470. Morphological and functional imaging in obstructive airway disease

P4598

A new method for detection of flow limitation in COPD using dynamic chest X-ray examination

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Purpose: Spirometry which requires maximum effort tasks COPD patients. In this study, we proposed a new method for detection of flow limitation without effort breathing.
Subjects: Dynamic chest X-ray from 10 normal volunteers, 16 mild COPD patients (GOLD Stage I or II) and 12 severe COPD patients (GOLD Stage III or IV) were obtained in the upright position in about 10 seconds of tidal breathing at rest. The dynamic image data captured at 7.5 frames per second was synchronized with the pulsed X-ray. The institutional review board approval and written informed consent were obtained in all persons.
Methods: We calculated the maximal differential values in each ventilation phase at the corresponding small local area of lung in the series of dynamic chest X-ray. The regional relative flow rate ratio was obtained from the peak values of inspiratory phase divided by the peak values of expiratory phase. All groups were compared about the average of flow rate ratio.
Results: The regional changes in inspiratory/expiratory flow rate ratio had larger values and broader distribution in COPD patients than those of normal volunteers. The average of the ratio in normal volunteers, in mild COPD patients and in severe COPD patients were 1.08±0.09, 1.17±0.08 and 1.19±0.13 (mean±SD), respectively. A significant difference was confirmed between the normal volunteers and the COPD patients ($p = 0.031$).
Conclusion: The inspiratory/expiratory flow rate ratios in COPD patients were larger than those of healthy volunteers. The new method for ventilation function has possibility to evaluate flow limitation without effort breathing.

P4599

Gravity dependence of lung density and specific gas volume (SVg) assessed by CT in health and emphysema

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Introduction: Lung density and SVg variations between different lung volumes are reliable estimates of regional lung emptying/filling (Salito et al,Radiology,2009). Here the gravity-dependent regional differences occurring within the lung in both health (H) and emphysema (E) is evaluated.
Methods: 10 healthy volunteers and 10 subjects with severe emphysema (FEV1<50%pred, RV/TLC≥0.65) were acquired at TLC and RV via static high-resolution-CT. For each subject, three levels, aortic arch (AA), carina (C) and top diaphragm (TD), were chosen to register through an optical-flow-based method the RVslice to the correspondent TLC one. Pixel-by-pixel differences between TLC and RV were computed in terms of both Hounsfield Unit (HU) ($\Delta HU=HU_{RV}-HU_{TLC}$) and SVg ($\Delta SVg=SVg_{TLC}-SVg_{RV}$) and resumed as mean differences in ventral, central and dorsal regions.
Results: H showed significant ventro-dorsal differences: in left lung, ΔHU mean increased from 146.4±4.7 (ventral) to 180.8±20.8 (dorsal) ($p=0.012$) at AA, from 136.6±4.2 to 196.2±24.1 ($p<0.001$) at C, from 116.5±23.8 to 214.8±24.5 ($p<0.001$) at TD. In right lung ΔHU increases were less pronounced but still significant. No significant differences occurred in E: in left lung, from 7.9±2.7 to 6.1±11.0 at AA, from 8.8±3.6 to 7.1±10.1 at C, from 10.5±4.4 to 21.3±11.1 at TD. In right lung ventro-dorsal differences were still non-significant. In both H and E, ΔSVg showed no significant ventro-dorsal differences.
Conclusions: a) ΔHU is gravity-dependent in H but not in E; b) Healthy ΔHU gravity-dependence is higher at TD compared to more apical levels; c) ΔSVg is not gravity influenced and therefore a more reliable measure of regional lung emptying/filling.

P4600

Lung structure in healthy neversmokers and smokers assessed by CT-densitometry and chest X-ray

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Background: Smoking causes inflammation in the lungs, which may lead to structural changes and irreversible airways obstruction, characteristic for COPD. By computered tomography (CT), areas with Hounsfield units (HU) below -950 have been considered as emphysema, while increased attenuation may indicate inflammation. We investigated changes in smokers compared to neversmokers.
Materials and methods: 40 current smokers (35±12 pack-years; mean ± SD) with normal lung function and 36 healthy neversmokers performed chest X-ray and CT. Age was 45-65 years with equal sex distribution. Lungs were defined as voxels with attenuation between -300 to -1024 HU, further divided into eight intervals. Chest X-rays were evaluated according to 4 criteria: depressed diaphragm, irregular radiolucency, abnormal retrosternal space and sternodiaphragmatic angle >90°. Two or more criteria's was considered as emphysema.
Results: Mean lung attenuation in male (-858HU±34; mean± SD) and female smokers (-856HU±19) was higher than in neversmokers (male -880HU±20; females- 872HU±18) ($p<0.05$ for both). In women, the percent of areas with HU below -950 was lower in smokers than neversmokers ($p<0.001$), the difference was smaller in men ($p<0.05$). Chest X-ray detected emphysema in 22% of male and 15% of female smokers, but in none of the neversmokers.
Discussion: Increased lung density in smokers may indicate inflammation but this has to be correlated to other signs of local inflammation. Females may be more vulnerable than males to the effects of smoking. Despite normal lung function, a considerable number of subjects had emphysema on plan chest x-ray. Further analyses are in progress including patients with COPD.

P4601

Specific gas volume (SVg) variations between different lung volumes in health and emphysema

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Introduction: Variation of specific gas volume (SVg) between high and low lung volume is a reliable estimate of regional lung filling/emptying (Salito et al,Radiology,2009). The aim of this study was to evaluate how these variations are distributed in different regions of the lung in healthy and COPD subjects.
Methods: 10 healthy volunteers and 10 subjects with severe emphysema (FEV1<50%pred, RV/TLC≥0.65) were scanned at TLC and RV via static high-resolution-CT. For each subject, three levels, aortic arch (AA), carina (C) and top diaphragm (TD), were chosen to register through an optical-flow-based method the RV slice to the correspondent TLC slice. For each level pixel-by-pixel SVg differences between TLC and RV ($\Delta SVg=SVg_{TLC}-SVg_{RV}$) were calculated. Frequency distribution plots of ΔSVg at the different levels were then expressed in terms of mean, median, standard deviation and skewness.
Results: Table 1 reports the pertinent values of the frequency distribution of ΔSVg in healthy and COPD subjects for each tracheo-bronchial tree level.

Population	Health			Emphysema		
Level	AA	C	TD	AA	C	TD
Mean (ml/g)	5,0±1,1	5,0±1,0	5,3±0,9	1,5±0,8***	1,4±0,8***	1,9±0,9***
Median (ml/g)	4,8±1,1	4,8±0,9	5,2±0,9	0,9±0,5***	0,8±0,4***	1,3±0,5***
Standard Deviation (ml/g)	2,7±0,7	2,9±0,8	3,1±0,7	8,6±1,3***	8,2±1,8***	7,8±2,3***
Skewness (ml/g)	1,1±0,9	1,0±1,3	0,7±1,7	0,3±0,3	0,2±0,3	0,3±0,4

***$p<0.001$ vs healthy.

Conclusions: In severe emphysema ΔSVg is smaller at any lung level, suggesting that alveolar destruction and gas trapping are homogeneously distributed within the lung. Regional distribution of SVg in emphysema presents an high degree of heterogeneity respect to healthy.

P4602

Gender and age related changes in upper airway morphology in a population of obese/OSA children

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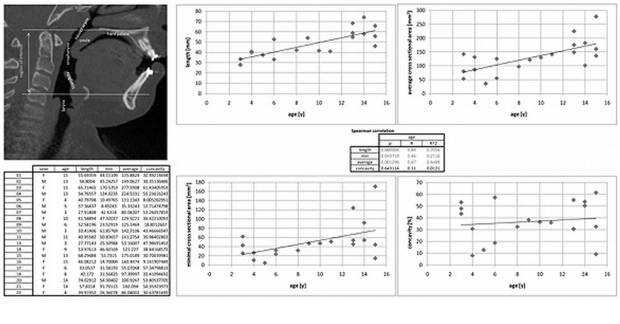
Introduction: This study aims to investigate the gender and age related changes in upper airway morphology in a population of obese/OSA children.



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Methodology: 20 children (10M/10F, average age 9.2y [3-15]) underwent an end inspiratory CT scan of the upper airway region. Using segmentation techniques a three dimensional reconstruction of the upper airway geometry is made, starting at the hard palate and reaching down to top of the larynx. For this region the length, the minimal and average cross sectional area, and the concavity (minimal area divided by average area) are calculated.
Results: No gender related differences in upper airway shape are observed. Age does correlate with upper airway length, minimal and average cross sectional area. The concavity of the upper airway does not correlate with age.
Conclusion: Upper airway imaging and segmentation can be used to phenotype specific OSA populations.

P4603
Airway dimensions in COPD patients: Relationship with lung functions
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Background: There is growing attention about evaluating the airway abnormality in chronic obstructive pulmonary disease (COPD) using airway dimensions.
Objective: To investigate relationship between airway dimensions measured by multi-slice spiral CT (MSCT) and lung functions in COPD patients.
Methods: 25 COPD patients and 15 healthy subjects underwent MSCT scans and pulmonary function test.The airway wall thickness (T) and airway luminal area (Ai) of apical bronchus of the right upper lobe in the CT images were measured.The ratio of T and the total diameter (T/D) and percentage of airway wall area to outer area (WA%) of the bronchus were calculated from T and Ai.Ventilation function,lung volume,airway resistance and diffusion function were detected in pulmonary function test.
Results: There were significant differences between COPD patients and healthy subjects in T/$\sqrt{\text{bodysurfacearea(BSA)}}$, T/D, Ai/BSA and WA%.

Table 1. Airway dimensions in the two groups

	COPD patients	Healthy subjects
T/$\sqrt{\text{BSA}}$, mm/m	1.5±0.3	1±0.2#
T/D	0.3±0.05	0.2±0.02#
Ai/BSA, mm^2/m^2	4±2	6±2*
WA%, %	81.1±8.1	72.2±4.1#

*P<0.05; #P<0.01

T/$\sqrt{\text{BSA}}$, T/D, Ai/BSA and WA% correlated with airway obstruction (FEV1%) and vital capacity (VC), T/$\sqrt{\text{BSA}}$ and WA% also with airway resistance (Raw) and residual volume (RV), T/D also with Raw and diffusion function (DLCO).

Table 2. Correlation(r) between airway dimensions and lung functions in COPD patients

	T/$\sqrt{\text{BSA}}$	T/D	Ai/BSA	WA%
FEV1%	–0.719#	–0.706#	0.547#	–0.706#
Raw%	0.378*	0.411*	0.328	0.460*
VC%	–0.421*	–0.508*	0.534#	–0.557#
RV%	0.578#	0.134	0.145	0.408*
DLCO%	–0.345	–0.485*	–0.248	–0.286

*P<0.05; #P<0.01.

Conclusions: Airway dimensions measured by MSCT correlated strongly with lung functions and provided large amount of information about the airway abnormality in COPD.

P4604
Bone mineral density (BMD) in male patients with chronic obstructive pulmonary disease (COPD) in age 40-70 years
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Background: COPD is often associated with the systemic extra pulmonary effects such as osteoporosis.
Aim and objectives: To study the dynamics of BMD in the course of COPD progression.
Material and methods: We examined 72 COPD male patients (aged 40-70 years). The COPD pts were subdivided into groups according to COPD severity: the 1st was made of 14 men; GOLD I stage; mean age 55 years; FEV1 78%; BMI 27 kg/m^2, smokers 68%, packs/yrs 20; the 2nd included 43 patients; GOLD II stage; mean age 57; FEV1 63%; BMI 28 kg/m^2, smokers 80%, packs/yrs 21; the 3d -20 patients; GOLD III stage; mean age 60; FEV1 41%; BMI 24,5 kg/m^2, smokers 84%, packs/yrs 28. All the findings were compared in 34 normal age-, sex- and BMI-matched control subjects. BMD was measured in spine (L1-L4) and femoral necks (FN) in 106 men using DEXA.
Results: The level of BMD was significantly lower in 3d group in comparison with control both in spine (0,992±0,156 vs.1,252±0,119 g/CM2, p<0,01) and at femoral necks (0,824±0,136 vs. 0,985±0,065 g/CM2, p<0,01). Osteopenia and osteoporosis were diagnosed in 51% and 11% cases in the 2nd group; 30% and 60% in the 3d group respectively. Osteopenia was revealed in 50% patients in the 1st group. We found the negative significant correlations between packs/yrs and BMD of L1-L4 (r=-0,55); with BMD of FN (r=-0,38).
Conclusions: The significant decrease of BMD was found in the course of COPD progression.

P4605
The relationship between inspiratory capacity and emphysematous changes assessed by CT in Vietnamese COPD patients
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Introduction: It is known that low attenuation volume (LAV) assessed by computed tomography (CT) is related to the severity of chronic obstructive pulmonary disease (COPD). However, the relationship between the regional distribution of emphysema assessed by LAV and inspiratory capacity is not clear.
Objectives: To investigate the relationship between IC and emphysematous changes in each lobe.
Methods: We recruited 76 Vietnamese COPD patients who underwent chest CT and respiratory function tests. We analyzed volumetric CT data and measured the fraction of low attenuation volume (LAV%) in each lobe. We then evaluated the relationship between LAV% in each lobe and inspiratory capacity.
Results: LAV% of the whole lung was significantly related to inspiratory capacity (r=-0.278, p=0.021). LAA% in right lung and left lung were significantly related to inspiratory capacity (r=-0.275, p=0.022, and r=-0.2715, p=0.024, respectively). LAV% of the right upper lobe and middle lobe was not related to inspiratory capacity (p=0.075 and p=0.457, respectively). LAV% of the right lower lobe was significantly related to inspiratory capacity (r=-0.354, p=0.003). LAV% of the left upper lobe was not related to inspiratory capacity (p=0.072). LAV% of the left lower lobe was significantly related to inspiratory capacity (r=-0.371, p=0.002).
Conclusion: Inspiratory capacity is affected more strongly by the emphysematous changes in the lower lobes than in the upper lobes.

P4606
CT densitometry as a predictor of pulmonary function in lung cancer patients
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Purpose: Preoperative pulmonary assessment is undertaken in patients with resectable lung cancer to identify those at increased risk of perioperative complications. Guidelines from the American College of Chest Physicians indicate that if the FEV_1 and DLCO are ≥60% of predicted, patients can undergo resection without further evaluation. [1]
The aim of our study is to determine if CT can predict pulmonary function in lung cancer patients and identify patients who would tolerate surgical resection.
Materials and methods: Patients were identified retrospectively from the Cork University Hospital lung cancer database. The total lung volume, the volume of normal lung parenchyma (values -500 HU to -900 HU), the emphysematous volume (values less than -900 HU), and the mean lung density were determined for each patient using the OsiriX digital analysis programme.
Results: A total of 77 patients were enrolled. FEV_1 was found to correlate significantly with the mean lung density (r=.762, p<.001) and the emphysematous volume (values less than -900 HU) (r= -.678, p<.001). DLCO correlated significantly with the mean lung density (r =.648, p<.001).
Through multivariate regression analysis, a cumulative prediction tool to predict pulmonary function was designed. The prediction tool was internally valid as there was no significant difference observed between the pulmonary function measures acquired by spirometry and the measures obtained using our prediction tool.
CT had a sensitivity of 84% and a specificity of 81% at detecting patients that require further assessment beyond pulmonary function testing.
Conclusion: Use of our prediction tool can predict pulmonary function in lung cancer patients.

P4607
The relationship between echodensitometric parameters of respiratory muscles (RM) and indices of body composition (IBC) in men with chronic obstructive pulmonary disease (COPD)
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Introduction: RM undergo an adaptive reductive remodeling.
Aim: To investigate changes of active expiration RM in COPD pts.
Methods: The peak histograms of muscles (external and internal oblique (extOAM and intOAM), transverses and rectus abdominal and internal intercostals) were detected by ultrasonic scanner. We investigated the indices: homogeneity (H), structural density (SD) and echogenicity (E). Fat mass (FM) and Lean mass (FFM) were determined by DXA. FM, FFM were expressed as ratios to height squared

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to get FMI, FFMI. The COPD pts were subdivided into groups: the 1st was made of 14 men; I stage (GOLD); mean age 55 yrs; BMI 27 kg/m^2; the 2nd - 43 pts; II stage; mean age 57; BMI 28 kg/m^2; the 3d -20 pts; III stage; mean age 60 yrs; BMI 24,5 kg/m^2.
Results: Indices H, SD decrease, while E increases in COPD pts v. control and in process of severity growth of COPD. We have established the positive significant correlations of E with FMI (r=0,61), and negative one between SD and FMI (r=-0,7) of extOAM in the 1st group. The positive significant correlation was detected between E and FMI (r=0,52) and negative one between H and SD of extOAM and FMI (r=-0,42 and r=-0,52) in the 2nd group. The 3d group characterized by the positive significant correlations between E and FFMI (r=0,69) and negative one between H and SD of extOAM and FMI (r=-0,7 and r=-0,75). The index E of intOAM correlated with FMI and FFMI (r=0,62 and r=0,63). Similar results were characteristic of other muscles.
Conclusions: The possible mechanism of the changes in COPD patients could be protein replacement with fat in muscles.

P4608
Distribution of CT-quantified emphysema: Association with lung function decline
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Background: Previous studies showed that subjects with similar extents of CT-quantified emphysema, but with different locations within the lung show different degrees of airflow obstruction.
Aim: To assess the association between CT-quantified emphysema distribution (upper/lower lobe) and lung function decline in heavy smokers participating in a lung cancer screening trial.
Methods: 587 participants underwent CT-scanning of the lungs and pulmonary function testing at baseline and after a median (interquartile range) follow-up of 2.9 (2.8-3.0) years. The lungs were automatically segmented based on anatomically defined lung lobes. Severity of emphysema was automatically quantified per anatomical lung lobe and was expressed as the 15th percentile technique (point below which 15% of the low attenuation areas voxels are distributed). Linear mixed models, correcting for age, height, BMI, packyears and smoking status, were used to assess the association of emphysema distribution and FEV_1/FVC-decline.
Results: Mean (SD) age was 60.2 (5.4) years, mean baseline FEV_1/FVC was 71.6 (9.0)% and overall mean Perc15 was -908.5 (20.9) HU. Participants with upper lobe predominant emphysema had a 1.71% (95% confidence interval 0.79 - 2.64) lower FEV_1/FVC after follow-up compared to participants with lower predominant emphysema (p=0.001), independently of the total extent of emphysema
Conclusion: Upper lobe predominant emphysema may be a different phenotype than lower lobe predominant emphysema.

P4609
Tracheo-bronchial collapsibility in different clinically determined COPD phenotypes
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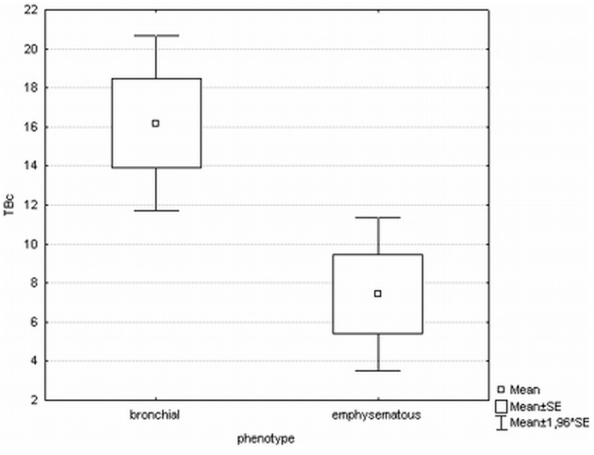
Tracheo-bronchial collapsibility (TBc) has been detected at computed tomography (CT) in Chronic Obstructive Pulmonary Disease (COPD). TBc is considered a local response to inflammatory agents not closely related to the obstructive functional pattern and to lung attenuation values at CT. We hypothesize however that TBc could influence symptoms and daily performance in patients with COPD. The purpose of our study was to investigate whether TBc is related to dyspnoea, exercise capacity and clinical phenotypes in patients with COPD.
Thirty-six patients (mean age 68±8, mean FEV1% 60±24) underwent clinical examination, lung function test, 6 minutes Walking Test and inspiratory-expiratory CT.TBc was measured by an automated software and correlated with MRC and Borg dyspnoea scales and with walked distance. Moreover we compared TBc in patients with predominant chronic bronchitis (CB) and predominant emphysema (E) phenotypes according to the rule available at www.clipcopd.com.
No significant relationship was found between TBc and MRC (r=-0.24, p=0.15), Borg scale (r=-0.12, p=0.48),walked distance (r=0.17, p=0.33). TBc was significantly higher in patients with CB phenotype (p=0.02, Fig. 1).
Patients with a predominant CB phenotype show a high level of TBc supporting the idea that the same inflammatory process could involve both trachea and bronchial tree. Dyspnoea and exercise capacity are global indexes of COPD that are not related to TBc.



P4610
Computed tomographic diagnosis of air trapping in non- or mildly obstructed smokers
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Background: Small airways disease (SAD) is an important cause of airflow limitation in smokers. In vivo quantification of SAD in smokers may aid in automated identification and phenotyping of COPD. The optimal CT method of air trapping quantification, a measure of small airways disease, has not been established yet.
Purpose: To test three quantitative CT air trapping measures that correct for emphysema extent against the residual volume over total lung capacity ratio (RV/TLC) as reference standard for air trapping.
Methods: In 447 current or former heavy smokers volumetric inspiratory-expiratory CT scans, spirometry and body plethysmography were obtained on the same day. The expiratory to inspiratory ratio of mean lung density ($E/I\text{-ratio}_{MLD}$), the relative inspiratory to expiratory volume change between Hounsfield units (HU) -860 and -950 ($RVC_{-860to-950}$) and the expiratory percentage of voxels between -780HU and -910HU ($EXP_{-780to-910}$) were calculated. ROC analysis was performed with RV/TLC as reference test, and the areas under the ROC curves (AUC) were compared to each other. The optimal cut-off and sensitivity and specificity was calculated for the best method.
Results: The $E/I\text{-ratio}_{MLD}$ showed an AUC (95% CI) of 0.84 (0.81-0.88), and performed significantly better than the $RVC_{-860to-950}$ (AUC=0.70, p<0.001) and $EXP_{-780to-910}$ (AUC=0.81, p=0.03). An $E/I\text{-ratio}_{MLD}$ >87% had a sensitivity of 0.82 and a specificity of 0.80 for the detection of abnormal RV/TLC.
Conclusion: The expiratory to inspiratory ratio of mean lung density on CT is the optimal quantitative CT measure for air trapping detection in current or former heavy smokers. This measure may prove important in future COPD research.

P4611
Visual versus quantitative assessment of airways disease in COPDGene
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Background: Visual airway assessment may provide unique data not captured by automated methods; cut points for distinguishing "abnormal" from "normal" do not exist with quantitative CT (QCT) measures. We sought to understand the relationship between QCT and visual airway measures.
Methods: 198 COPDGene cohort scans (GOLD I-IV) were reviewed by pulmonologists and radiologists (9-11 reviewers/scan) for presence of airway wall thickening (AWT). Logistic regression and area under the receiver operating curve (AUC) analyses determined the relationship between median AWT score and QCT measures including segmental and subsegmental wall area percent (WAP), wall thickness, lumen diameter and pi10 (standardized airway wall thickness at internal perimeter of 10 mm). Multivariate regression adjusted for age, gender, and smoking history was used to predict FEV_1%, SGRQ and history of chronic bronchitis.
Results: Subsegmental WAP (AUC=0.72, p<0.001) and pi10 (AUC 0.75, p<0.001) best predicted the presence of visual AWT. A pi10 value of 3.78 (95th percentile normals/66th percentile COPD) provides 80% specificity and 55% sensitivity; a WAP value of 66 (>99th percentile normals/74th percentile COPD) provides 80%

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specificity and 53% sensitivity. Subsegmental WAP predicted a similar degree of variability in FEV_1% compared to AWT (r^2=0.33 vs 0.32). Visual score better predicted chronic bronchitis symptoms (AUC 0.73 vs 0.66) and SGRQ score (r^2=0.23 vs 0.16).
Conclusions: Expert panel visual airway score correlates best with subsegmental WAP and pi10 in the >90th percentile range for normals. Each method provides unique information; in particular, visual analysis scores appear to be more closely associated with clinical symptoms.

P4612
Analysis of activation process of dyspnea sensation in CNS in patients with COPD measured by fMRI
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Introduction: Dyspnea is the cardinal symptom of COPD. Localization of dyspnea sensation in the brain has been studied by a small number of investigators. However little is known about transmission and activation of dyspnea sensation in CNS.
Objectives: We analyzed pathway and localization of dyspnea sensation in the brain of normal subjects and COPD patients using functional magnetic resonance imaging (fMRI).
Methods: Six normal subjects (M/F; 5/1, 53.7±5.9 yr: mean ± SEM) and 4 COPD patients (M/F; 4/0, 68.5±1.7 yr) were recruited. After informed consent, these subjects were requested to breathe through resistive loads ranging from 5 to 50 cm H2O/L/sec adjusted by the Borg CR10 Scale. The subjects received 1minute of repetitive resistive-loaded breathing three times with 1minute interval. During these process, brain activity was analyzed by 3 Tesla scanner (Signa Excite HD; GE Healthcare).
Results: Activation of bilateral sensory cortices was recorded among 6 normal subjects and 4 COPD patients. In addition, VPM in bilateral thalami was also activated in all subjects when subjects breathed with the resistive load. There was no difference of the localization of activated portions during resistive-loaded breathing between in normal subjects and in COPD patients. Values of the resistive load to induce thalamic and cortical activation were significantly lower in COPD patients than those in normal subjects.
Conclusion: Activation of thalamus and sensory cortex was dependent on the resistive load among normal subjects and COPD patients. The resistive loads on COPD patients to induce the thalamic activation were significantly lower than those on the normal subjects.

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Anatomically derived regional measurement of lung function
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Existing methods for quantifying lung ventilation and perfusion SPECT scans provide measurements which are either global, based on division of the lung into non-anatomical regions or based on the application of a generic lung model of lung anatomy. The objective of this work is to develop a technique to use HRCT data to automatically define sub-lobar regions corresponding to anatomical lung segments and to align these with SPECT/CT data acquired separately from the same subject. This can be achieved by performing a non-rigid registration between the HRCT data, acquired at full inspiration, and the low-res CT data captured as part of the SPECT procedure, acquired during tidal breathing. Once the transform required to bring these two data sets into alignment has been determined, it can be applied to the sub-lobar regions to map these to the low-res CT and hence to the SPECT data. This process of non-rigid registration is achieved using a free-form polynomial warp algorithm, which automatically determines the optimum elastic transform required to bring the HRCT and low-res CT data sets into alignment.
HRCT scans are analysed using commercially available software to define the airway tree geometry, which is then used to seed a Voronoi space division algorithm to divide the lung into segments based on the branches of the airway tree. Early results have shown that it is possible to robustly divide the lung into the regions based on the segmental branches of the airway tree and good alignment between single 2D slices and the SPECT images has been obtained.
The method will be extended to work in 3D and the results so far indicate that this will be a viable method to produce anatomically relevant measurements of lung function.

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