156. Functional lung and pulmonary arterial imaging

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Diffusion weighted MR can improve preoperative lung cancer diagnosis

Johan Coolen[1], Frederik De Keyzer[1], Paul De Leyn[2], Johan Vansteenkiste[3], Walter De Wever[1], Herbert De Caluwe[2], Christophe Dooms[3], Eric Verbeken[4], Willy Coosemans[2], Dirk Vanraemdonck[2], Yolande Lievens[5], Christophe Deroose[6], Vincent Vandecaveye[1], Kristiaan Nackaerts[3], Steven Dymarkowski[1], Johny Verschakelen[1]. *[1]Radiology, University Hospitals AZ Gasthuisberg, Leuven, Belgium; [2]Thoracic Surgery, University Hospitals AZ Gasthuisberg, Leuven, Belgium; [3]Pneumology, University Hospitals AZ Gasthuisberg, Leuven, Belgium; [4]Pathology, University Hospitals AZ Gasthuisberg, Leuven, Belgium; [5]Radiotherapy, University Hospitals AZ Gasthuisberg, Leuven, Belgium; [6]Nuclear Medicine, University Hospitals AZ Gasthuisberg, Leuven, Belgium*

Purpose: Since diffusion-weighted MR (DW-MR) has shown promise in differentiating benign from malignant disease in several oncologic applications, we aimed to evaluate the potential role of this technique in differentiating benign from malignant lung lesions.
Material and methods: 50 patient staged with PET-CT and operated because of proven lung cancer or having a suspicious lung opacity were included. DW-MR was performed one day before surgery. DW-MR was evaluated first by visual inspection of all MR images by a chest radiologist and second by calculating the ADC values. Both PET/CT and DW-MR findings were correlated with pathology.
Results: Good correlation was found between DW-MR and pathology (κ=0.56, $p<0.0001$), whereas PET/CT performed worse (κ=0,20, p=0.1457). In total, 33 patients were diagnosed correctly with PET/CT, 7 incorrectly and 10 undetermined. DW-MR staged 45 patients correctly and 5 incorrectly. The 10 undetermined cases on PET/CT were correctly diagnosed on DW-MR. Pure ADC-average based diagnose showed an optimal threshold of 0.00152 mm^2/s between benign and malignant lesions, with sensitivity and specificity of 91 and 57% respectively.
Conclusion: DWI-MR could become an appropriate diagnostic instrument for preoperative lung cancer patients in the near future because it has a high accuracy for differentiating benign from malignant lung lesions.

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Comparison of four-dimensional (4D) CT ventilation imaging with SPECT V/Q scans

Tokihiro Yamamoto[1], Sven Kabus[2], Jens von Berg[2], Cristian Lorenz[2], Michael Goris[3], Billy Loo[1], Paul Keall[1,4]. *[1]Radiation Oncology, Stanford University, Stanford, CA, United States; [2]Digital Imaging, Philips Research Europe, Hamburg, Germany; [3]Nuclear Medicine, Stanford University, Stanford, CA, United States; [4]Radiation Physics Laboratory, University of Sydney, Sydney, NSW, Australia*

Background: A novel ventilation imaging method based on 4D-CT has advantages over existing methods. However, little validation has been performed.
Purpose: To compare 4D-CT ventilation imaging (V_{CT}) with SPECT ventilation (V_{SPECT}) and perfusion (Q_{SPECT}) scans.
Methods: V_{CT}, V_{SPECT} and Q_{SPECT} were acquired for 3 patients. V_{CT} was compared with V_{SPECT} and Q_{SPECT}. The spatial overlap of defects was assessed using the dice coefficient (DC). The defects were determined by (1) thresholding the SPECT images with 20%, 30% or 40% of the maximum value in the lung and (2) segmenting the same volume with lower values in V_{CT}.
Results: V_{CT} was of higher resolution than SPECT. Figure shows example images. Visually, regions of both agreement and disagreement were identified.

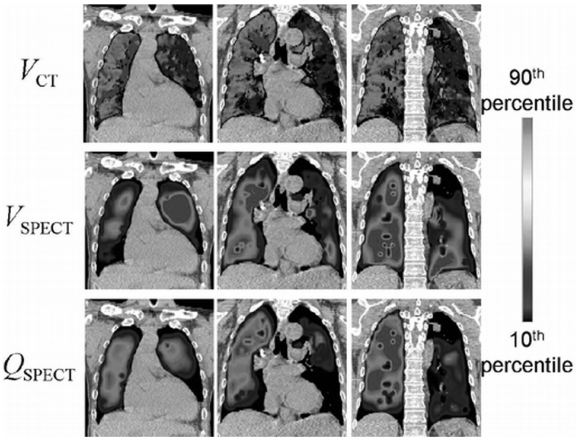

Table shows DCs (mean±SD) between the V_{CT} and V_{SPECT} or Q_{SPECT} defects. V_{SPECT} suffered from central airway depositions of aerosols, which drove extremely high correlations. There were moderate correlations with Q_{SPECT} in all patients. Lower thresholds yielded consistently lower DCs due to differences in low-value regions.

Threshold	V_{SPECT}		Q_{SPECT}	
	% Defect volume	DC	% Defect volume	DC
20%	92.7±2.7	0.93±0.02	36.9±3.1	0.51±0.09
30%	98.1±0.5	0.98±0.01	61.3±3.8	0.69±0.09
40%	99.3±0.2	0.99±0.01	78.1±7.2	0.82±0.07

Conclusions: The 4D-CT ventilation moderately correlated with the SPECT V/Q. Ongoing studies focus on investigating more patients and spatial characteristics of the differences.

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Micro-CT and ^{18}F-FDG micro-PET of pulmonary fibrosis in mice induced by adenoviral gene transfer of TGF-β1

Thomas Rodt[1], Christian von Falck[1], Roman Halter[2], Claudia Boehm[3], Matthias Luepke[3], Florian Laenger[4], Jack Gauldie[5], Juergen Borlak[2], Frank Wacker[1], Ulrich Maus[6]. *[1]Diagnostic and Interventional Radiology, Hannover Medical School, Hannover, Germany; [2]Pharmaceutical Research und Medical Biotechnology, Fraunhofer-Institute for Toxicology and Experimental Medicine, Hannover, Germany; [3]General Radiology and Medical Physics, University of Veterinary Medicine Hannover, Hannover, Germany; [4]Pathology, Hannover Medical School, Hannover, Germany; [5]Medicine, Pathology and Molecular Medicine, McMaster University, Hamilton, Canada; [6]Experimental Pneumology, Hannover Medical School, Hannover, Germany*

Introduction: The morphological and functional information provided by micro-CT and micro-PET allows monitoring of acute and chronic disease states in small laboratory animals. We examined in-vivo micro-CT and micro-PET as non-invasive tools to assess pulmonary fibrosis in mice.
Material/Methods: Pulmonary fibrosis was induced in mice by intratracheal delivery of an adenoviral gene vector encoding biologically active TGF-β1. Respiratory gated and ungated micro-CT was performed in 18 mice at 1 to 4 weeks after pulmonary adenoviral gene vector delivery. In 5 additional mice ^{18}F-FDG micro-PET and micro-CT was performed. Imaging was correlated to histopathology and findings in animals exposed to a control vector. Radiation doses were measured using thermoluminescence dosimeters.
Results: Significant correlation between Ashcroft histology scoring and micro-CT was found for visual assessment scoring ($p<0.001$) and automated quantification by a region growing segmentation algorithm ($p=0.004$ for gated and $p=0.006$ for ungated exams). ^{18}F-FDG micro-PET showed slight increase of glucose metabolism in the consolidated lung areas determined by micro-CT, which was coregistered to the micro-PET data using anatomical landmarks. Radiation doses for micro-CT ranged from 174 to 277 mSv. For micro-PET an expected dose of 140 mSv was calculated from the measurements.
Conclusion: Micro-CT and micro-PET allow valid visualisation of morphology and metabolism for the assessment of fibrosis in mice. The measured radiation doses allow serial examinations without deterministic radiation effects.

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Association of texture-based quantitative fibrotic patterns and pulmonary function test in a new validation set

Hyun Kim, Matthew Brown, Fereidoun Abtin, Peiyun Lu, Daniel Chong, Jonathan Goldin. *Center for Computer Vision and Imaging Biomarkers, Department of Radiological Sciences and Thoracic Imagining Research Group, David Geffen School of Medicine, University of California-Los Angeles, Los Angeles, CA, United States*

Background: Under non-volumetric CT scan, a texture-based quantitative lung fibrosis (QLF) score has been developed as a computer-aided diagnostic metric in a scleroderma-related interstitial lung disease (SSc-ILD) [1].
Objective: To test an association the QLF from CT score with pulmonary function tests in new study cohort.
Methods: From our anonymized research database, 119 subjects with SSc-ILD (mean age 48±10.6 years and 70.7% ±14.3 of FVC) underwent baseline CT scans with high-resolution, volumetric, 64 detectors in the prone position at full inspiration. The extents of fibrotic patterns were measured as a QLF score in 5 steps: 1) denoise images; 2) grid-sample at a fixed location; 3) convert the characteristics of intensities into texture features; 4) classify voxels as fibrotic or non-fibrotic patterns based on texture features and 5) report fibrotic voxels as percentages. Associations were tested by Spearman rank correlation.
Result: Correlations between pulmonary function test and QLF were similar in the previous study and this new cohort as shown below.
Conclusion: The quantitative fibrotic patterns in whole lung can be a useful prognostic metric of severity and the heterogeneity of distribution in fibrotic patterns in lobes can be used as an index.

Correlation between QLF and pulmonary function test

ρ (p-value)	QLF score in the evaluation set [1]	QLF score in the new cohort
FVC	–0.31 ($p<0.0001$)	–0.53 ($p<0.0001$)
DLCO	–0.35 ($p<0.0001$)	–0.35 ($p<0.0001$)
FEV1	–0.23 ($p=0.0001$)	–0.45 ($p<0.0001$)

Reference:

[1] Kim HJ, Tashkin DP, Clements PJ, et al. A computer-aided diagnosis system for quantitative scoring of extent of lung fibrosis in scleroderma patients. Clin Exp Rheumatol. 2010 (5 Suppl 62); S26-35.

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Transthoracic echocardiography and pulmonary artery pressure assessment in patients with COPD exacerbation

Szymon Skoczynski[1], Katarzyna Mizia-Stec[2], Grzegorz Brozek[1], Ewa Sozanska[1], Zbigniew Gasior[2], Wladyslaw Pierzchala[1]. *[1]Department of Pulmonology SP CSK in Katowice, Medical University of Silesia, Katowice, Poland; [2]II Department of Cardiology, GCM in Katowice, Medical University of Silesia, Katowice, Poland*

Background: Transtchoracic echocardiography (TTE) is accepted as screening tool for pulmonary hypertension (PAH), nerveless it is rarely performed in COPD patients due to possible difficulties caused by hyperinflated lungs.
Aims and objectives: The aim of our study was to find out whether it would be possible to predict if TTE is capable to assess pulmonary artery pressure (PAP) in patients with COPD exacerbation.
Methods: 40 consecutive patients with COPD exacerbation were enrolled. TTE directed for diagnosis of PAP, pulmonary function tests, blood gases, six minute walking test and BORG scale were performed at baseline and after successful treatment.
Results: It was possible to perform TTE in 17 (42,5%) subjects on admition and in 26 (65%) at discharge. PAH was present in 88,2% pre-treatment, and in 80,8% post-treatment (PAP mean≥25 mmHg), and in 35,3% pre-treatment and in 52,9% post-treatment (RVSP>35 mmHg). It was possible to measure PAPmean in 94,1% patients pre-treatment, and in 96,2% post-treatment, whereas it was possible to measure RVSP in 58,8% patients pre-treatment before, and 65,4% post-treatment. Simple as well as multivariable analysis did not find predictive value ($p>0,05$) of the following parameters: FEV_1, FVC, IC, RV%TLC, TLC, ITGV, TLCO/VA, pO2, pCO2, 6MWT distance, BORG scale, COPD stage (GOLD), BMI, pack-years, sputum purulence to prognose possibility of obtaining accurate TTE results.
Conclusions: TTE may be used as noninvasive tool in assessment of PAPmean and in much smaller extent in assessment of RVSP in patients with COPD exacerbation, but it still seems impossible to predict in which patients it would be possible to perform accurate TTE.

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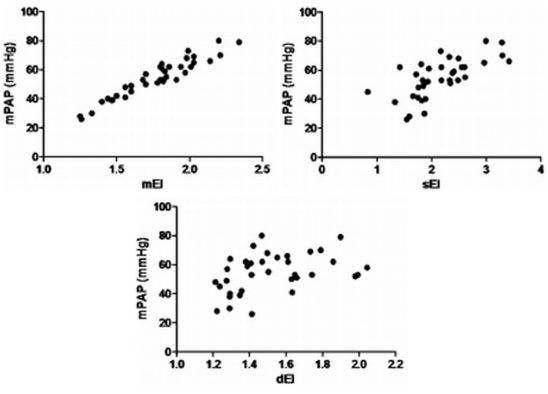
Mean eccentricity index strongly reflects mPAP in patients with IPAH using CINE cardiac MRI

Andrew Swift[1,2], Smitha Rajaram[2], Robin Condliffe[3], Helen Marshall[2], Dave Capener[2], Judith Hurdman[3], Charlie Elliot[3], David Kiely[3], Jim Wild[2]. *[1]Cardiovascular Biomedical Research Unit, National Institute of Health Research, Sheffield, United Kingdom; [2]Academic Unit of Radiology, University of Sheffeild, Sheffield, United Kingdom; [3]Sheffield Pulmonary Vascular Disease Unit, Sheffield Teaching Hospitals NHS Foundation Trust, Sheffield, United Kingdom*

Introduction: Left ventricular systolic eccentricity index (sEI) measured at echocardiography has been shown to correlate with pulmonary artery pressure in patients with pulmonary hypertension (PH). This study assesses the relationship of sEI, diastolic eccentricity index (dEI) and mean eccentricity index (mEI) with mPAP in patients with idiopathic pulmonary arterial hypertension (IPAH) using CINE cardiac MRI.
Methods: We studied 36 patients with IPAH who underwent RHC and MRI within



48 hours. MR imaging was performed on a 1.5T whole body scanner GE HDx (GE Healthcare), short axis (SA) cine images were acquired using a cardiac gated multi-slice balanced steady state free precession sequence. Measurements were obtained from the mid-chamber SA end-systolic image and end diastolic images, the ratio D2/D1 was calculated in systole and diastole, where D2 is the diameter parallel and D1 is perpendicular to the IVS. mEI is calculated from (sEI +dEI)/2. A second observer (SR) repeated the measurements.

Results: The correlation between mEI and mPAP was highly significant at r=0.95, $p<0.0001$. Weaker yet significant correlations were found between sEI verses mPAP, r=0.69 and dEI verses mPAP, r=0.40.

A good level of interobserver agreement was demonstrated for our eccentricity index measurements, k=0.80.

Discussion: A strong relationship between mEI and mPAP has been demonstrated in our cohort of patients with IPAH.