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Dear APSR colleagues,

Quantitative imaging of airways is the process of quantifying airway dimensions using thoracic images such as Computed Tomography (CT), optical coherence CT, microCT, magnetic resonance imaging (MRI), and histology. Indexes of airway dimensions which can be quantified are airway internal area (A_i), total airway area (A_o), airway wall area (WA), and derivatives of these indexes. Quantitative imaging of airways helps clinicians and researchers to look into pathophysiology, to complement pulmonary function tests predicting clinical symptoms or prognosis, to characterize specific phenotypes, to evaluate response of certain therapy in patients with airway diseases. In this issue of the APSR Respiratory Updates, we want to highlight some important findings about quantitative imaging of airways published recently on international journals.

Sincerely,

Nguyen Van Tho, Emiko Ogawa, Hiroshi Wada, Yasushi Ryujin, Rie Kanda and Yasutaka Nakano
Division of Respiratory Medicine, Department of Medicine, Shiga University of Medical Science, Shiga, Japan

Small-Airway Obstruction and Emphysema in Chronic Obstructive Pulmonary Disease

Authors: John E. McDonough et al.

Reference: N Engl J Med 2011;365:1567-75

URL: <http://www.nejm.org/doi/full/10.1056/NEJMoa1106955>

Comment: This study was conducted to examine the relationship between numbers and dimensions of small airways and emphysematous destruction in COPD. Number of small airways per lung as seen on thoracic multi-slice CT was significantly reduced in patients with COPD compared to the controls. Using the microCT scans with 16.24- μ m spatial resolution, the total number and total cross-sectional areas of terminal bronchioles were substantially reduced in patients with severe COPD compared to controls. A comparison of the number and dimensions of terminal bronchioles at different levels of emphysematous destruction measured using histology showed that the narrowing and loss of terminal bronchioles preceded emphysematous destruction in COPD. This study has shed new light on the relationship between small airway obstruction and emphysema in the process of COPD development.

Gender Differences of Airway Dimensions in Anatomically Matched Sites on CT in Smokers

Authors: Yu-Il Kim et al.

Reference: COPD 2011;8:285–292

URL: <http://informahealthcare.com/doi/full/10.3109/15412555.2011.586658>

Comment: Gender differences of airway dimensions in smokers are still controversial. This study was conducted to investigate the gender differences of airway dimensions of anatomically matched airways in 2047 smokers. Airway dimensions of each bronchial generation in each patient were averaged from 6 bronchial pathways. Airway internal area (Ai), internal diameter and wall thickness (WT) were smaller in women than men in all bronchial generations. However, women had greater wall area percentage (WA%) in subsegmental and subsubsegmental bronchi than men. In multivariate regression analysis, gender remained one of the most significant predictors of WA%, Ai, internal diameter, and WT. Gender differences of airway dimensions in this large study may help explain gender differences in the presentation and pathophysiology of COPD.

Association Between Airway Caliber Changes With Lung Inflation and Emphysema Assessed by Volumetric CT in Subjects with COPD

Authors: Alejandro A. Diaz et al.

Reference: *Chest*; Published online before print on September 22, 2011; DOI: 10.1378/chest.11-1026

URL: <http://chestjournal.chestpubs.org/content/early/2011/09/21/chest.11-1026>

Comment: Emphysema levels in patients with COPD may influence airway dilation (airway distensibility) during lung inflation. The change of airway calibers of the right upper apical segmental bronchus and right lower basal posterior segmental bronchus between relaxed exhalation and full inspiration scans were evaluated in relation with emphysema measured at full inspiration. There was a significant decrease in global airway distensibility of the 3rd and 4th-airway generation in emphysema-predominant subjects in COPD groups, compared to the controls. There was a significant inverse association between global airway distensibility and whole-lung emphysema. This report implies that bronchodilators may be less effective in subjects with emphysema-predominant phenotype.

Measurement of Lung Airways in Three Dimensions using Hyperpolarized Helium-3 MRI

Authors: Eric T Peterson et al.

Reference: Phys. Med. Biol. 2011;56:3107–3122

URL: <http://iopscience.iop.org/0031-9155/56/10/014/>

Comment: Quantitative CT is considered as the gold standard for assessing airway dimensions. However, its application is limited in certain subjects due to the ionizing radiation. This study was conducted to validate the accuracy of hyperpolarized He-3 MRI (HPHe MRI) as an alternative method of measuring large airway internal diameter. For 32 airway segments from an excised and desiccated porcine lung, HPHe MRI and quantitative CT produced similar results. For 309 airway segments from 24 human subjects, airway diameters derived from MRI were correlated well with those derived from CT. However, compared to CT measurements, MRI underestimated airway internal diameter due to MRI scans were performed at the earlier phase of inspiration. This study implies that HPHe MRI may be an alternative modality of airway measurement for subjects who have contraindications to CT.

Comparison of Airway Remodeling Assessed by Computed Tomography in Asthma and COPD

Authors: Kaoruko Shimizu et al.

Reference: Respiratory Medicine 2011;105:1275-1283

URL: <http://www.sciencedirect.com/science/article/pii/S0954611111001351>

Comment: Few studies have directly compared airway remodeling assessed using CT between asthma and COPD. This study compared airway dimensions between the two groups of patients with similar air-flow limitation. Mean airway wall area percentage (WA%) and internal area (Ai) of each generation from the 3rd to 6th generation of bronchi were calculated from 8 bronchi for each patient. At any generation, WA% was larger and Ai was smaller in asthma, both followed by COPD and then controls. This is one of the studies to confirm that airway remodeling is more prominent in severe persistent asthma than in COPD.

Quantitative Computed Tomography Measures of Emphysema and Airway Wall Thickness are Related to Respiratory Symptoms

Authors: T.B. Grydeland et al.

Reference: *Am J Respir Crit Care Med* 2010;181:353–359

URL: <http://ajrccm.atsjournals.org/content/181/4/353.long>

Comment: There is limited knowledge about the relationship between respiratory symptoms and quantitative computed tomography based phenotypes of COPD.

The square root of wall area for a hypothetical airway with an internal perimeter of 10 mm (AWT-Pi10) was independently and significantly related to dyspnea among subjects with COPD, even after adjustment for FEV₁% predicted. AWT-Pi10 was significantly related to morning cough, chronic cough, and wheezing attacks in 463 subjects with COPD and to wheezing attacks in 488 subjects without COPD. This is the first study to suggest that airway wall thickness measured using quantitative CT can complement FEV₁ in predicting respiratory symptoms in patients with COPD.

Clinical and Radiographic Predictors of GOLD-Unclassified Smokers in the COPDGene Study

Authors: Emily S. Wan et al.

Reference: *Am J Respir Crit Care Med* 2011;184:57–63

URL: <http://ajrccm.atsjournals.org/content/184/1/57.long>

Comment: Smokers who have a post-bronchodilator FEV₁ less than 80% predicted and FEV₁/FVC greater than or equal to 0.7 (GOLD-U subjects) are a poorly characterized group. GOLD-U subjects represent 9.1% of the first 2,500 subjects recruited in COPDGene study. In terms of quantitative CT variables, airway wall area percentage (WA%) of subsegmental bronchi in GOLD-U subjects was significantly higher than in smoking control subjects, but significantly lower than in subjects with COPD. In the multivariate regression analysis, WA% of subsegmental bronchi was one of the significant and independent predictors of GOLD-U status. This is the first study to extensively characterize GOLD-U subjects based on clinical and quantitative CT variables. Increased subsegmental airway wall thickness may represent a differential response to cigarette smoke in this group of subjects.

Chronic Obstructive Pulmonary Disease Exacerbations in the COPDGene Study: Associated Radiologic Phenotypes

Authors: MeiLan K. Han et al.

Reference: *Radiology* 2011;261: 274-82

URL: <http://radiology.rsna.org/content/261/1/274.long>

Comment: The association between COPD exacerbation frequency and airway dimensions measured using quantitative CT has not been investigated in studies with large sample size. Mean airway wall thickness and wall area percentage of each among 1002 patients with COPD were calculated from 6 segmental bronchi. In a multivariate regression analysis adjusted for lung function, increasing wall thickness was significantly associated with increased exacerbation frequency. At low levels of emphysema, the influence of bronchial wall thickness on frequency of exacerbation is greater than the influence of the emphysema. This study implies that quantitative CT measures of airway dimensions can help identify patients at risk for more frequent exacerbations.

The Chronic Bronchitic Phenotype of COPD : An Analysis of the COPDGene Study

Authors: Victor Kim et al.

Reference: *Chest* 2011;140:626-633

URL: <http://chestjournal.chestpubs.org/content/140/3/626.long>

Comment: Current literature is limited regarding the clinical and quantitative CT characteristics of chronic bronchitic phenotype in COPD. Airway wall area percentage (WA%), wall thickness percentage (AWT%) and square root of wall area for a hypothetical airway with an internal perimeter of 10 mm (AWT-Pi10) were calculated from 6 segmental bronchi for each among 1061 patients with COPD including 290 patients with chronic bronchitis (CB) and 771 patients without CB. WA% was significantly greater in CB group than in non CB group. However, AWT% and AWT-Pi10 were not different between the two groups. The inconsistent difference of airway dimensions between the two groups implies that WA% may be the better index of airway inflammation than the other measures.

Effects of Adding Omalizumab, an Anti-Immunoglobulin E Antibody, on Airway Wall Thickening in Asthma

Authors: Makoto Hoshino et al.

Reference: Respiration; Published online before print on January 11, 2012. DOI: 10.1159/000334701

URL: <http://content.karger.com/ProdukteDB/produkte.asp?doi=10.1159/000334701>

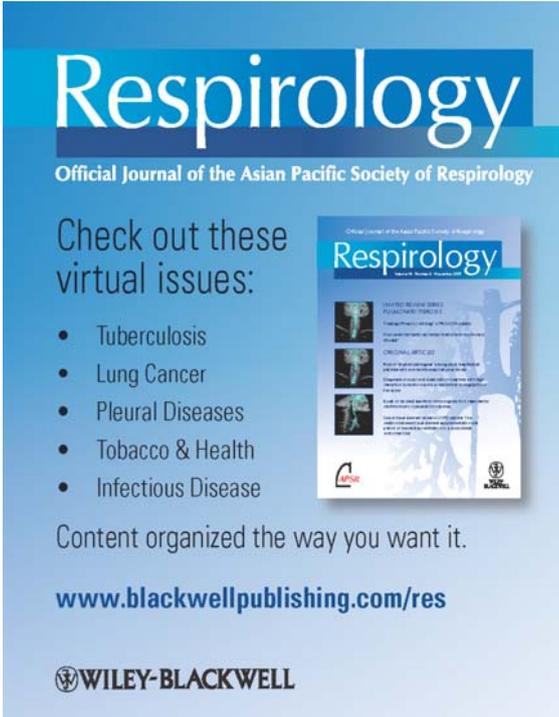
Comment: There is limited knowledge about the effects of omalizumab, an anti-IgE medication, on airway dimensions in patients with severe persistent asthma. CT measurements of airway dimensions of the right upper apical segmental bronchus of 14 patients with and 16 patients without omalizumab were repeated after 16 weeks of therapy. Treatment with omalizumab significantly decreased airway wall thickness and increased lumen area, whereas conventional therapy resulted in no change. Change in wall area percentage correlated with changes in FEV₁% and eosinophil. This study implies that airway dimensions measured using quantitative CT can be used as indexes for evaluation of response in clinical trials in asthma.

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Articles selected and commented on by Nguyen Van Tho, Emiko Oga-wa, Hiroshi Wada, Yasushi Ryujin, Rie Kanda and Yasutaka Nakano; Division of Respiratory Medicine, Department of Medicine, Shiga University of Medical Science, Shiga, Japan.

Coordinator: Dr David CL Lam, Department of Medicine, University of Hong Kong, Hong Kong, China

Compiled by Dr Christel Norman, Respirology Editorial Office, Perth, Australia



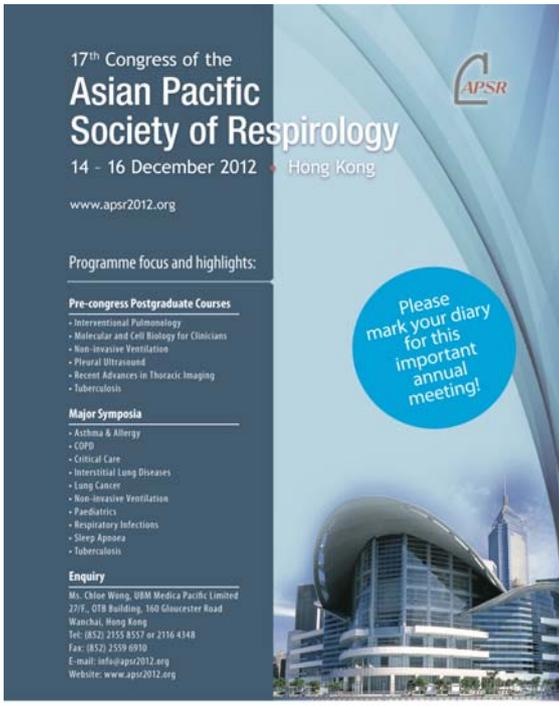
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Enquiry

Ms. Chlon Wong, IBM Medica Pacific Limited
27/F, QTB Building, 160 Gloucester Road
Wanchai, Hong Kong
Tel: (852) 2155 8557 or 2116 4148
Fax: (852) 2159 6910
E-mail: info@apsr2012.org
Website: www.apsr2012.org

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Hong Kong Thoracic Society **Hong Kong Lung Foundation**

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