Respiratory physiology: new tools, old concepts

P130 DYNAMIC HYPERINFLATION IS ASSOCIATED WITH A POOR CARDIOVASCULAR RESPONSE TO EXERCISE IN COPD PATIENTS

doi:10.1136/thoraxjnl-2011-201054c.130

[1]P Tzani, [2]M Aiello, [2]D Elia, [2]L Boracchia, [2]E Marangio, [2]D Olivieri, [3]E Clini, [1]A Chetta. *[1]Cardio Pulmonary Department, Lung Function Unit, University Hospital, Parma, Italy; [2]Cardio Pulmonary Department, Respiratory Disease, University Hospital, Parma, Italy; [3]Department of Oncology, Haematology, Respiratory Diseases and Ospedale Villa Pineta di Gaiato, University of modena and Reggio Emilia, Pavullo, Italy*

Background Pulmonary hyperinflation has the potential for significant adverse effects on cardiovascular function in COPD. The aim of this study was to investigate the relationship between dynamic hyperinflation and cardiovascular response to maximal exercise in COPD patients.

Methods We studied 48 patients (16F; age 68 yrs ±8; BMI 26±4) with COPD. All patients performed spirometry, plethysmography, Lung diffusion capacity for carbon monoxide (TLco) measurement, and symptom-limited cardiopulmonary exercise test (CPET). The end-expiratory lung volume (EELV) was evaluated during the CPET. Cardiovascular response was assessed by change during exercise in oxygen pulse (ΔO_2 Pulse) and double product, that is, the product of systolic blood pressure and heart rate (DP reserve), and by the oxygen uptake efficiency slope (OUES), that is, the relation between oxygen uptake and ventilation.

Results Patients with a peak exercise EELV (%TLC) ≥75% had a significantly lower resting FEV_1/VC, FEF_{50}/FIF_{50} ratio and IC/TLC ratio, when compared to patients with a peak exercise EELV (%TLC) <75%. Dynamic hyperinflation was strictly associated to a poor cardiovascular response to exercise: EELV (%TLC) showed a negative correlation with ΔO_2 Pulse ($r = -0.476$, p=0.001), OUES ($r = -0.452$, p=0.001) and DP reserve ($r = -0.425$, p=0.004). Furthermore, according to the ROC curve method, the EELV (% TLC) cut-off point which maximised sensitivity and specificity, with respect to a DP reserve value <10 000 as threshold value, was ≥75 % (0.76 sensitivity and 0.80 specificity).

Conclusion The present study shows that COPD patients with dynamic hyperinflation have a poor cardiovascular response to exercise. This finding supports the view that in COPD patients, dynamic hyperinflation may affect exercise performance not only by affecting ventilation, but also cardiac function.

P131 CT EMPHYSEMA SCORE, DYNAMIC HYPERINFLATION AND VENTILATORY EFFICIENCY DURING EXERCISE IN PATIENTS WITH COPD

doi:10.1136/thoraxjnl-2011-201054c.131

[1]D Elia, [2]N Sverzellati, [1]P Tzani, [1]M Aiello, [1]V Vecchio, [1]E Marangio, [3]A Chetta. *[1]Cardiopulmonary Department, Respiratory Disease Unit University Hospital, Parma, Italy; [2]Department of Clinical Sciences, Section of Diagnostic Imaging, University of Parma, Parma, Italy; [3]Cardiopulmonary Department, Lung Function Unit University Hospital, Parma, Italy*

Background Volumetric CT scan is used for evaluating the severity of emphysema in COPD patients. The aim of this study was to ascertain whether volumetric CT scan of emphysema may provide information on dynamic hyperinflation and ventilatory efficiency during exercise in COPD patients.

Methods We studied 20 patients (5 F; age 67 yrs ±9; BMI 26 kg/m^2 ±4) with COPD. All patients performed baseline lung function test, chest CT scan and symptom-limited cardiopulmonary exercise test. Dynamic hyperinflation and ventilatory efficiency were expressed as the end-expiratory lung volume (EELV, in l) at peak exercise and as the slope of the relationship between minute ventilation (l/min) and carbon dioxide production (l/min) during exercise (VE/VCO_2). Oxygen uptake (VO_2, % pred), dyspnoea and leg fatigue perception (VAS in mm/workload in watts) at peak exercise were also measured.

Results In all patients, a wide range of airflow obstruction was found (FEV_1/VC range: 31%–68%). The volumetric CT scan score mean value of emphysema was 32.4%±8.6 (range 15–50%). We found a correlation between CT scan score and VE/VCO_2 ($r=0.511$, p=0.02), peak exercise EELV ($r=0.521$, p=0.03), and peak VO_2 (% pred) ($r=-0.617$, p=0.004). Furthermore, the volumetric CT scan score was related to dyspnoea ($r=0.458$, p=0.04) and leg fatigue perception ($r=0.566$, p=0.009).

Conclusions Our study shows that the presence of emphysema, as assessed by volumetric CT scan, is associated to dynamic hyperinflation and poor ventilatory efficiency during exercise. Additionally, in our patients a reduced aerobic capacity and an increase in dyspnoea and leg fatigue on exertion were associated to high CT score.

P132 COMPARATIVE STUDY OF THE CURVILINEAR ULTRASOUND PROBE (CUP) VS THE LINEAR ULTRASOUND PROBE (LUP) TO MEASURE RECTUS FEMORIS CROSS SECTIONAL AREA (RFCSA)

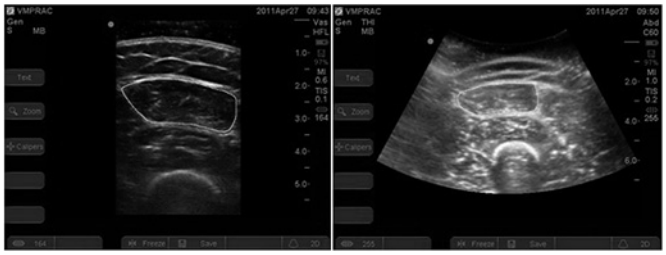
doi:10.1136/thoraxjnl-2011-201054c.132

[1]S Mandal, [2,3]B Connolly, [1]E Suh, [2]J Moxham, [1,3]N Hart. *[1]Lane Fox Respiratory Unit, Guy's, St Thomas' NHS Foundation Trust, London, UK; [2]Division of Asthma, Allergy and Lung Biology, King's College London, London, UK; [3]Guy's and St Thomas' NHS Foundation Trust and King's College London, National Institute Health Research Comprehensive Biomedical Research Centre, London, UK*

Introduction The use of a LUP has been validated in measuring RFcsa in healthy subjects and COPD patients. A technical concern of this method in obese patients is that although the standard LUP has sufficient resolution it may have an insufficient width window and penetration to measure RFcsa. In contrast, the CUP has sufficient penetration, but insufficient resolution. We hypothesised there would be no difference between RFcsa measured with the LUP and CUP and that the "spliced" RFcsa using the LUP has the same value as the whole RFcsa.

Method Subjects had RFcsa measured at 2/3 of the distance from the anterior superior iliac spine to superior border of the patella. Image acquisition was made using real time B-mode ultrasonography using a 6 MHz linear probe and 2–5 MHz curvilinear probe. Whole and matching "spliced" RFcsa images were acquired in a subgroup. RFcsa measurements were calculated offline using the Image J® programme.

Results 27 subjects (5 COPD patients; 22 healthy subjects) were scanned. Of these, 14 had whole RFcsa images visualised with the LUP. These were compared with RFcsa images obtained using the CUP (Abstract P132 figure 1). There was no difference between the LUP and CUP RFcsa measurements (mean LUP RFcsa 344 (112) mm^2 vs mean CUP RFcsa 364 (110) mm^2; p=ns; intraclass correlation coefficient r=0.95). In addition there was no significant differences between mean "spliced" and whole images (335 (110) mm^2 vs 344 (112) mm^2; p=ns). Three measurements were acquired with each probe with the mean CV of 2.4% and 2.78% for the CUP and LUP, respectively. For the spliced images, the mean CV was 2.5%.



Abstract P132 Figure 1 RFcsa taken with a linear probe (image on left) and curvilinear probe (image on right) in the same individual at 2/3.

Conclusion These data demonstrate that both linear and curvilinear probes can be used to acquire accurate RFcsa measurements. Furthermore, "splicing" the images from the LUP, when a CUP is not available is a justified method to assess RFcsa. This method should be considered for RFcsa image acquisition in obese patients.

P133 LUNG CLEARANCE INDEX IS A REPRODUCIBLE AND SENSITIVE MEASURE OF AIRWAYS DISEASE IN BRONCHIECTASIS

doi:10.1136/thoraxjnl-2011-201054c.133

[1]S Rowan, [1]J Bradley, [1]M Ennis, [2]A Horsley, [3]N Bell, [4]P Gustafsson, [1]J S Elborn. *[1]Queens University Belfast, Belfast, N Ireland; [2]University of Manchester, Manchester, UK; [3]Bristol Royal Infirmary, Bristol, UK; [4]Central Hospital, Skovde, Sweden*

Introduction Lung clearance index (LCI) is a measure of ventilation in homogeneity derived from multiple breath washout (MBW). Although FEV_1 is commonly used to assess severity of airway disease and response to therapy, it is insensitive to small airways disease and is often within normal range in bronchiectasis (BE) not caused by Cystic Fibrosis (CF) until disease is well established. In CF, LCI is more sensitive than FEV_1 in detecting airways abnormalities and is currently used as an outcome measure in clinical trials. In BE, there is a need to find a sensitive outcome measure that is responsive to interventions, particularly in those with mild disease.

Objective To assess within and between visit repeatability of LCI and determine the relationship between FEV_1 and LCI in stable BE.

Methods Inclusion criteria: HRCT diagnosis of BE within the last 5 years; clinically stable (no infective symptoms for >4 weeks); no genetic or clinical features of CF. Participants attended for two visits, 2 weeks apart. At each visit they performed MBW in triplicate, using 0.2% sulphur hexafluoride and a modified Innocor device. LCI was derived from the mean of at least 2 acceptable washouts. Spirometry was performed to ATS/ERS standards.

Results 14 patients (8M/6F) attended for two visits. The mean (SD) age was 60.5 (15.4) yrs. Mean (SD) FEV_1 % predicted was 87.1 (18.6), range (44–117). Mean (SD) LCI was 9.4 (2.0) on visit 1 and 9.4 (1.9) on visit 2 (normal <7.5). The intra-visit coefficient of variation (CV) was 4.7 % (3 measures). Between visit repeatability of LCI was 0.54 (SD of variance between visits). LCI negatively correlated with FEV_1 ($r=-0.69$, $p<0.001$). Sensitivity of LCI and FEV_1 for the diagnosis of bronchiectasis by CT was 71% and 29% respectively.

Conclusions This is the first report of LCI in non-CF BE. LCI is a more sensitive test of lung function than FEV_1 and is abnormal in the majority of people with BE who have a normal FEV_1. LCI has good intra-visit and between visit repeatability. Across a range of FEV_1 there is a strong relationship between LCI and FEV_1.

P134 VALIDATING STRUCTURED LIGHT PLETHYSMOGRAPHY (SLP) AS A NON-INVASIVE METHOD OF MEASURING LUNG FUNCTION WHEN COMPARED TO SPIROMETRY

doi:10.1136/thoraxjnl-2011-201054c.134

[1]S Alimohamed, [1]K Prosser, [1]C Weerasuriya, [2]R Iles, [3]J Cameron, [3]J Lasenby, [4]C Fogarty. *[1]School of Clinical Medicine, University of Cambridge, Addenbrookes Hospital, Cambridge, UK; [2]Department of Respiratory Paediatrics, Cambridge University Hospitals, Addenbrookes Hospital, Cambridge, UK; [3]Signal Processing and Communications Laboratory, Department of Engineering, University of Cambridge, Cambridge, UK; [4]Department of Statistics, Harvard University, Cambridge, Massachusetts, USA*

Background Structured Light Plethysmography (SLP) is a recently developed technology for non-invasive and entirely non-contact monitoring of lung (respiratory) function. The system projects a structured light grid onto the thoraco-abdominal surface of the subject, which is imaged by two cameras giving a dynamic 3D reconstruction of the surface as the subject breathes. From this data we can infer changes in chest/abdomen volume over time, allowing us to extract parameters and generate curves (eg, Volume-Time, Flow-Time, Flow-Volume curves) directly comparable to conventional spirometry. SLP therefore hopes to provide an inexpensive replacement for conventional spirometry, which is an invasive methodology unusable in a number of patient classes (eg, neonates, young children, intensive care patients etc). This study tests the validity of SLP in terms of reproducibility, repeatability and position dependence, as compared to conventional spirometry (Pneumatach); by comparison of ventilation parameters extracted from both technologies.

Methods SLP and Pneumatach spirometry were used simultaneously to capture 120 datasets from 10 randomly chosen adult subjects. Each complete dataset contained tidal breathing and forced expiratory manoeuvres, in both sitting and standing positions. Operator-dependence (reproducibility) was tested by collecting data sets from each subject using three different operators. Repeatability was tested by collecting the data from each subject once, and then again after a 40 min break. Tidal Inspiratory Time (TI) parameters were extracted from the results and the data analysed using the paired Student t test.

Results There was no significant difference between TI values obtained from SLP compared to conventional spirometry throughout the study ($n=120$; $p=0.8556$). SLP comparisons of pooled mean TI before, and after a 40 min break were not significant (1.5589 vs 1.5595; $p=0.9938$); similarly, readings in different positions (sitting or standing) were not significantly different. SLP comparison of all three operator pairs (1vs2, 1vs3 and 2vs3), were not significant ($p=0.7361$, $p=0.9765$, $p=0.7343$, respectively).

Conclusions SLP measurements are not operator, time or position dependant. Therefore SLP shows a high degree of reproducibility and repeatability; and represents a promising, viable and non-invasive alternative to conventional spirometry.

P135 MAXIMUM INSPIRATORY FLOW MEASURED DIRECTLY WITH AN INSPIRATORY FLOW METRE COMPARED WITH MEASUREMENTS FROM FLOW VOLUME LOOP TRACES

doi:10.1136/thoraxjnl-2011-201054c.135

M C P Apps, M Skipper, J Skipper, S Basford, V Bryant, J Saines, T Andrews. *Queen's Hospital, Romford, UK*

Introduction Low Maximum Inspiratory Flow is characteristic of patients with muscle weakness, Laryngeal dysfunction, or Extra-thoracic airway obstruction. We have been exploring the use of an Inspiratory Flow Metre (In Check Dial- Clement Clarke International) to help in the identification of those patients who need more detailed investigation.