252. Respiratory and skeletal muscle assessment in health and disease

P2104

The effects of inspiratory muscle training on breathing mechanics during fixed load cycling exercise

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Previous research has found that inspiratory muscle training (IMT) can improve exercise performance and tolerance (McConnell and Romer 2004). Whether these improvements are related to changes in breathing mechanics during exercise is unknown. To investigate this, we tested the hypothesis that IMT would reduce inspiratory muscle strength during cycling exercise. Three physically active males cycled for 60 min at a fixed power output before and after 6 weeks of pressure-threshold IMT. Cycling power corresponded to maximum lactate steady state, estimated using a lactate minimum test (Tegtbur et al. 1993). Transdiaphragmatic pressure (P_{di}) was calculated as the difference between gastric and oesophageal pressures (P_e) measured using balloon pressure catheters. Transdiaphragmatic (PTP_{di}) and oesophageal (PTP_e) pressure-time products were calculated as the product of breathing frequency (f_R) and the P_{di} and P_e inspiratory time integrals respectively. P_{di}, P_e and respiratory variables were measured on a breath-by-breath basis. Following IMT, peak P_{di} decreased by (mean ± SD) 6.65±4.82 cmH_2O and PTP_{di} and PTP_e by 115±31 and 102±28 cmH_2O s min^{-1}, respectively. There was no change in the contribution of the diaphragm to total inspiratory force output (PTP_{di}/PTP_e). Minute ventilation and f_R were also reduced by 8.73±10.20 l min^{-1} and 4.06±2.70 breaths min^{-1}, respectively. In conclusion, inspiratory muscle strength is reduced during a 60 min fixed load cycling test following IMT. These findings suggest that one of the potential mechanisms by which IMT increases exercise tolerance may be by reducing the pressures required to sustain ventilation during fixed load cycling exercise.

P2105

Chest wall volume changes during normocapnic hyperpnoea with constant breathing pattern

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Introduction: Normocapnic hyperpnoea (NH), a common form of respiratory muscle endurance training (RMET) known to fatigue the diaphragm, is normally performed with constant tidal volume (V_T) while prolonged high ventilation (V_E), as with exercise, often results in rapid shallow breathing. We aimed to investigate the effect of fatiguing NH with constant V_E and V_T on respiratory muscle action. We hypothesised that inspiratory rib cage muscles would take over some of the inspiratory work of the diaphragm when the diaphragm fatigues.
Methods: 10 healthy subjects performed 1h of NH at 70% MVV (V_T: 2.6±0.6 l; breathing frequency: 40±6 breaths min^{-1}). Using optoelectronic plethysmography, we assessed the relative contribution of the chest wall compartments [pulmonary rib cage (RCP), its volume changes reflecting rib cage muscle action; abdominal rib cage (RCA) and abdomen (AB), volume changes of both reflecting diaphragm and abdominal muscle action] to V_T as well as their end-inspiratory (EIV) and end-expiratory volumes (EEV) at the beginning and at the end of NH.
Results: While relative compartmental contribution did not change during NH (RCP: 48±6 vs. 50±5%, RCA: 23±5 vs. 23±6%, AB: 29±7 vs. 27±5%; all $p>0.05$) EIV (1.1±0.2 vs. 1.0±0.3 l) and EEV (-0.1±0.1 vs. -0.3±0.2 l; both $p<0.05$) of RCP decreased with no change in EIV and EEV of RCA and AB.
Conclusion: Inspiratory rib cage muscles did not seem to take over work of the diaphragm. However, in- and expiratory rib cage muscles play an important role in preventing the development of rapid shallow breathing. Thus, RMET likely provides a training stimulus not only to the diaphragm but also to the rib cage muscles.
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P2106

Chest wall kinematics during different levels of positive end-expiratory pressure in cystic fibrosis children

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Objective: To study the effects of different levels of positive end expiratory pressure (PEEP) on compartmental chest volumes.
Methods: Twelve patients with CF (12±2.7 years; FEV1/FVC%:81.3%±6.6 and FEV1%:69±12) and ten age-matched healthy subjects (control group-CG); 11±1.8 years) with normal lung function. Both groups were evaluated by Optoelectronic Plethysmography in 3 minutes of quite breathing (QB), 3 minutes breathing against 3 levels of PEEP, 10 cmH2O, 15 cmH2O and 20 cmH2O.
Results: Both groups were similar during QB. Intergroup analyses shown that tidal volume of chest wall was different between CF and CG at PEEP10 (Vtcw=0.486±0.180L vs 0.920±0.500L,p=0.0236; respectively) and at PEEP20 (Vtcw=0.511±0.170L vs. 0.996±0.430L, p=0.0005; respectively). We found differences in respiratory rate between groups at PEEP15 (RR=42.1±17.1 bpm vs RR= 22±6.74,p=0.006), and PEEP20 (RR=37.2±19.3 vs 20.3±8.17,p=0.034). CF intragroup analyses shown that Vtcw increased significantly in all levels of PEEP compared to QB (Vtcw=0.286±0.079L vs PEEP10= 0.487±0.181L vs PEEP15=0.515±0.21L and PEEP20=0.512±0.177L, $p<0.001$), but no differences were found between PEEPs levels. End expiratory lung volume increase in CF group during PEEP20 in comparison to QB (Veecw=10.2±3.24L vs 10.7±3.58L, $p<0.001$), end inspiratory lung volume increase in all levels of PEEP when compared to QB (Veicw=10.5±3.26L vs PEEP10=11±3.46L, PEEP15=11±3.49L and PEEP20=11.2±3.6L, $p<0.05$).
Conclusion: The use of PEEP10 and PEEP20 induced different changes in chest wall volumes in CF and CG. All levels of PEEPs improve chest wall volumes in CF children's.

P2107

Influence of aerobic exercise training on respiratory muscle strength in obese Thai women

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Obesity is one of major risk factors for developing several respiratory diseases which is probably linked to respiratory muscle impairment. This study aimed to determine whether aerobic exercise training improves respiratory muscle strength (RMS) in obese women. Inspiratory pressure from residual volume (PImaxRV) or function residual capacity (PImaxFRC), sniff nasal inspiratory pressure (Pnsn) and maximal expiratory pressure (PEmax) were measured in 13 obese women pre- and post-aerobic exercise training programme performed at least 30 min per session; 3 sessions per week for 12 weeks. Results showed that aerobic exercise training significantly reduced body mass indices (BMI) (29.8±2.9 vs. 28.7±2.9 kg/m^2, fat mass (27.1±3.8 vs. 23.9±3.76 kg) and body fat (37.3±2.5 vs. 34.2±2.5% ($p<0.001$) whereas fat free mass did not alter. Compared with pre-exercise, RMS was significantly greater in post-exercise ($p<0.001$), e.g. absolute PImaxRV (126.1±25.2 vs. 116.±28.8 cmH_2O), PImaxFRC (119.8±26.4 vs. 105.8.1±1524.8 cmH_2O), Pnsn (113.2±122.1 vs. 98.1±21.2 cmH_2O) and PEmax (127.3±24.7 vs. 119.8±26.4 cmH_2O). The data suggest that aerobic exercise training in obese women studied appears to increase the RMS which may be, partly, a consequence of decreased fat mass and body fat.

P2108

Inspiratory muscle strength training: A pilot study on laryngeal movements

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Introduction: Exercise induced vocal cord dysfunction (VCD) is a common condition, often confused with exercise induced asthma with unfortunate consequences.

The evidence base for conservative treatment is limited but two single-case reports suggest effects from inspiratory muscle strength training (IMST).
Objectives: To run a pilot study that objectively visualizes laryngeal response pattern(s) to controlled training with IMST.
Methods: Ten healthy volunteers (range 21-26), were examined at rest with video recorded continuous transnasal flexible laryngoscopy while performing a standardized training program using a resistive loading device (Respifit S). The resistance during the training sessions were set at maximal and 60-80% of the maximal attainable inspiratory mouth pressure (PI_{max}). Laryngeal movements were scored by a senior laryngologist according to a preset scheme.
Results: Resistance set at 60-80% of PI_{max} produced a measurable glottic abduction in all subjects. Increasing the inspiratory pressure to PI_{max}, revealed no change in the abduction in seven subjects, while in two subjects abduction appeared to decrease. In one subject a paradoxical adduction was observed. Supraglottic adduction was seen in two patients at PI_{max}. In all subjects larynx moved downwards during inspiration, and nine of ten subjects seemed to engaged all muscle groups in the hypopharynx during inspiration at PI_{max}.
Conclusion: The study suggests that IMST may be an efficient tool in the treatment of exercise induced VCD. Large interindividual differences suggest a need for individual training programs, and underscores that objective methods must be used during instructions and training with IMST in these patients.

P2109
Diaphragm and quadriceps muscle fatigue in self-paced cycling exercise of different durations
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Introduction: Individuals are believed to pace cycling intensity in a time trial (TT) such that the level of quadriceps muscle fatigue (QF) attained is similar independent of cycling conditions. We aimed to assess whether diaphragm fatigue (DF), known to affect leg muscle fatigue, would also reach similar levels between different tests.
Methods: 12 healthy, young athletes (67.1±6.3 ml min^{-1} kg^{-1}) performed 15 and 30min cycling time trials (15TT, 30TT; randomised), on two different days. DF and QF were assessed by measuring reductions in esophageal and gastric (transdiaphragmatic) pressure/quadriceps force during magnetic phrenic/femoral nerve stimulation after exercise relative to before ($\Delta P_{di,tw}$; ΔQ_{tw}).
Results: The average degree of $\Delta P_{di,tw}$ did not differ -21.2±12.8% (15TT) vs. -17.6±9.3% (30TT; p=0.228) while ΔQ_{tw} of the shorter and more intensive test -34.0±5.7% (15TT) was significantly larger than that of the longer test -29.5±6.9% (30TT; p=0.044). Individual between-test differences of $\Delta P_{di,tw}$ did not correlate with those of ΔQ_{tw}. However, individual $\Delta P_{di,tw}$ of both TTs taken together significantly correlated with the workload of the finish (last 30 s) relative to the maximal workload (R^2=0.30; p=0.005).
Conclusion: The present work does not support the notion that the level of QF is the same, independent of cycling TT conditions. Knowing that DF develops early during exercise, these findings may indicate that DF possibly affected finish intensity via afferent feedback from the fatigued diaphragm, attenuating central motor output to working limb muscles.

P2110
Dyspnoea, respiratory muscle strength and hyperventilation in end-stage liver disease
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There are scarce reports on respiratory muscle strength in end-stage liver disease patients. On the other hand, decreased $PaCO_2$ due to hyperventilation is well documented in patients with end-stage liver disease. Chronic dyspnoea is frequently reported by these patients, but it is not known if it is related to respiratory muscle strength and/or hyperventilation. We studied 48 consecutive, ambulatory, Caucasian patients (37 men) with end-stage liver disease, awaiting for liver transplantation. Chronic dyspnoea was rated according to the modified Medical Research Council (mMRC) 6-point scale. Routine lung function tests, maximum static expiratory (Pemax) and inspiratory (Pimax) mouth pressures were measured. Pattern of breathing (V_E: minute ventilation; V_T: tidal volume; RR: respiratory rate; V_T/T_I: mean inspiratory flow; T_I/T_{TOT}: duty cycle; T_I: duration of inspiration) was also measured. Forty-three patients reported some degree of dyspnoea (mean±SD). mMRC was 2±1.1, Pemax%pred was 106±33 and Pimax%pred was 91±28. These pressures were found below the normal limits in 13 and 16 patients, respectively. Furthermore, mMRC was significantly correlated with Pemax and Pimax (r=-0.49, p<0.001; r=-0.41, p<0.01, respectively). V_E (11.5±3.4, l), V_T (0.770±0.311, l), RR (16±4, bpm) and V_T/T_I (0.46±0.13, l sec^{-1}) were increased and $PaCO_2$ (33±4, mmHg) was decreased, indicating hyperventilation. In contrast T_I/T_{TOT} (0.42±0.05) was normal. Statistically significant correlations were found for mMRC with T_I and RR (r=-0.32, p=0.03; r=0.32, p=0.03; respectively). We conclude that in end-stage liver disease, there is an interrelationship between chronic dyspnoea, respiratory muscle strength, and hyperventilation.

P2111
Reproducibility of diaphragm thickness measurements by ultrasonography
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Although diaphragmatic variations of the length of zone of apposition are readily studied by ultrasonography (US), only preliminary studies have shown the possibility to use US to measure diaphragmatic thickness (TD). In order to determine reference values of TD during various maneuvers and to assess US measurement reproducibility, 8 healthy subjects (4M, 4F) were studied in supine and standing position during spontaneous quiet breathing (QB), slow vital capacity (SVC), maximal inspiratory (MIP) and maximal expiratory (MEP) pressure maneuvers. TD was measured on lateral ribcage using an US linear probe (7.5 MHz). Six subjects were examined by two different operators on two different occasions on a short time period (2-3 days). Three subjects were examined by the same operator on two different occasions on a long time period (6-7 months). TD was determined by a custom-designed software for image processing at end-inspiration (EI) and end-expiration (EE) during QB, at TLC and at maximal pressures during MIP and MEP maneuvers. Overall average values are reported in the following table (values reported as mean±SD).

Diaphragm thickness (TD, mm)

	QB, EE	QB, EI	QB, EI-EE	TLC	MIP	MEP
Supine	1.45±0.45	1.83±0.54	0.38±0.42	2.80±0.66	3.29±0.68	1.18±0.27
Standing	1.56±0.36	1.91±0.49	0.36±0.44	2.68±0.70	3.25±0.82	1.19±0.30

ANOVA analysis revealed that no significant differences were present between inter- and intra-observer measures, in both postures, and on both short and long time periods (p>0.05).
In conclusion: a) US represent a reliable and reproducible method for TD assessment; b) TD varies of ~30% and ~20% in supine and standing position during QB; c) at TLC, TD is about two-fold higher than at FRC; d) during MIP, TD is maximum.

P2112
Effects of cardiomegaly on regional chest wall volume in patients with chronic Chagas cardiomyopathy
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Heart failure is commonly related to changes in breathing pattern in order to evaluate the specific effects of cardiomegaly on chest wall function in Chronic Chagas Cardiomyopathy (CCC) we studied 12 CCC patients with cardiomegaly ejection fraction (EF) of left ventricle < 45% of predicted value; age 57.08±8.52 years; body mass index (BMI) 24.63±4.83 kg/m^2) and 5 CCC patients without cardiomegaly (EF > 45; 68.8±6.83 years; 32.92±7.69 kg/m^2). Maximal inspiratory pressure (MIP) and chest wall volume by Opto-Electronic Plethysmography (OEP) were measured. OEP data were acquired during quite breathing (QB) and inspiratory loaded breathes (ILB) with threshold set at 50% of MIP.
During QB, patients with cardiomegaly showed lower percentage contributions to tidal volume of both pulmonary rib cage (VRCp%) (p=0.01) and abdominal rib cage (VRCa%) (p=0,02) compared to patients without cardiomegaly. During ILB, VRCa% (p=0.03), end-inspiratory (p=0.03) and end-expiratory (p=0.04) volumes of abdominal rib cage volume were reduced compared to patients without cardiomegaly. In conclusion, increased heart size within thoracic cavity affects chest wall function in the rib cage compartments. The lower rib cage displacement is affected especially during inspiratory efforts. This mechanical constraint leads to a restrictive breathing pattern, which is related to high elastic load to both inspiration and expiration.

P2113
Effect of thoracocentesis on respiratory muscle strength in patients with unilateral pleural effusion
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It has been known that patients with pleural effusion may display a temporary reduction in arterial oxygenation soon after removal of pleural fluid, a fact that

is in discrepancy with the relief of breathlessness after evacuation of effusions. We investigated changes in respiratory muscle strength before and after removal of several quantities of pleural fluid in patients with relatively large unilateral pleural effusions. We studied 49 patients (36 male & 13 female) aged 61±7.3 yrs. (mean±SD) with large unilateral pleural effusions of varying causes. Patients were selected on the basis of CT-scan not to have significant parenchymal lesions that would possibly interfere with lung physiologic properties (e.g. tuberculous effusions, neoplastic from extrathoracic primary site, hypoproteinemic effusions etc.) All patients were tested with an electronic mouth pressure meter, both before and 30 minutes after completion of thoracocentesis.The quantity of fluid removed was recorded for each patient and ranged from 0.38 to 1.41 L, with a mean value of 0.82±0.25 L (mean±SD). Maximal Respiratory Pressures were recorded 3 times and highest values were selected for statistical comparison (paired t-test).Maximal Inspiratory Pressure before removal of fluid (MIPb) was -74±12 cmH2O while after (MIPa) was -88±13 cmH2O ($p<0.01$). Maximal Expiratory Pressure before (MEPb) was 104±15 cmH2O while after removal of fluid (MEPa) was 121±17 cmH2O ($p<0.01$).We can conclude that removal of pleural fluid is accompanied by an improvement in respiratory muscle maximal pressures that may partly explain the relief of breathlessness after thoracocentesis.

P2114

Spinal behavior during tidal and deep breathing in healthy male subjects

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Spine has joint connections with all ribs and has muscle attachments with a part of diaphragm, suggesting a key role in respiratory mechanics. In this study, we aimed to investigate movement of the spine during tidal and deep breathing at a seated posture in which the spine was free from artificial restriction. Three-dimensional motion analysis using an eight-camera system (60Hz) was performed in fifteen male healthy volunteers (mean age; 27.1±5.7 years). During tidal breathing, the spine moved very little (< 1 mm) while ventral parts of the ribs and the sternum well moved (1.9-5.2mm) as "pump-handle". Lumber spine moved toward ventral direction with deep inspiration to TLC while upper thoracic spine did with deep expiration to RV. These results suggested that spine was almost fixed during tidal breathing as the pivot of the ribcage. Breathing to RV or TLC recruited varieties of supplemental respiratory muscles, and transformed spine.

P2115

Positive effects of inspiratory muscle training (IMT) on ventilatory response to progressive hypercapnia in healthy subjects

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Inspiratory muscle training (IMT) is known to improve inspiratory muscle capacity, whole body exercise capacity and the sensation of dyspnea.
Until now the effects of IMT on respiration during ventilatory stress, induced by hyperoxic progressive hypercapnia, have not been examined. We speculate that IMT, by improving inspiratory pump capacity, may affect ventilatory response during CO2-rebreathing.
Aim of the study: The aim of our study was to analyze the effects of IMT on the ventilatory response during CO2-rebreathing tests in healthy subjects.
Methods: Eight healthy subjects (4 males, 4 females) performed specific IMT for 6 weeks. Maximal inspiratory pressure (Pi max) and endurance time during resistive breathing manoeuvres (tlim) served as parameters for inspiratory muscle capacity.The ventilatory response to CO2, using the Read's rebreathing technique, was analysed twice before commencement of IMT and once on the day after stopping IMT.
Breathing pattern (Vt/VE),maximal achieved VE, as well as the sensation of dyspnea (BORG Scale) during CO2-rebreathing were analysed.
Results: After 6 weeks of IMT, inspiratory muscle capacity increased significantly. Maximal achieved VE (minute volume) as well as Vt (tidal volume) also increased significantly, while the level of dyspnea (Borg Scale) was lower.
Breathing pattern during ventilatory stress changed in that the proportion of tidal volume on minute volume increased significantly.
Conclusions: IMT leads to more effective respiration under ventilatory stress,even in healthy subjects.
This might be of clinical relevance for patients with lung diseases.

P2116

Maximum cough pressures are increased in patients with chronic cough

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Cough intensity can be defined with a variety of measures that include thoracic and abdominal pressure, airflow, electromyography and subjective scales. Little is known about cough intensity in patients with chronic cough. We investigated the physiological characteristics of cough intensity in patients with chronic cough and normal subjects.
15 patients with chronic cough and 14 healthy subjects underwent measurements of oesophageal pressure (Poes), gastric pressure (Pga), peak cough flow rate (PCFR), abdominal electromyographic activity and cough sound during voluntary coughs. The data from maximum cough efforts are presented. PCFR was normalised to predicted peak expiratory flow rate to account for gender and height differences.
There was no significant difference in gender, age or lung function between patient and control groups. Maximum cough Poes was higher in patients with chronic cough than controls (188 vs 146cmH2O, p=0.02). This difference was limited to females only; the male group was underpowered to detect a difference. Cough Pga (p=0.01) and normalised cough flow (p=0.03) were also higher in female patients than in controls.

All	Patients	Controls	p-value
M:F	3:12	5:9	ns
Age (yrs)	55 (17)	54 (23)	ns
Poes (cmH2O)	188 (49)	146 (51)	*0.02
Pga (cmH2O)	201 (38)	172 (60)	0.2
PCFR:predicted PEFR ratio	1.4 (0.4)	1.3 (0.5)	0.6
Female			
Poes (cmH2O)	181 (51)	132 (35)	*0.02
Pga (cmH2O)	199 (40)	148 (44)	*0.01
PCFR:predicted PEFR ratio	1.4 (0.4)	1.1 (0.5)	*0.03

Presented as mean (SD),

Female patients with chronic cough have higher maximum cough pressures and cough flows than healthy controls. Further studies are needed to identify underlying mechanisms and investigate whether these findings are also relevant to male patients with chronic cough.

P2117

Obesity and respiratory muscle power

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Introduction: In the past few decades obesity has become a global health problem. It could be a predisposing factor to a lot of cardiovascular, metabolic (such as diabetes mellitus) and respiratory problems that may result in pulmonary obstruction or restriction.
Objectives: The aim of this study was to investigate the effect of obesity on respiratory muscle power and so on lung functions.
Methods: This was a cross sectional study performed on 52 subjects (35 females and 17 males) in the age range 17-23 years in Khartoum state during the period February to May 2010. The body mass index (BMI) was computed following the standard equation (BMI (kg/m^2) = (weight/height2). The percent of body fat was measured using Skinfold Caliber at the back of upper arm. Obesity was defined following the internationally accepted BMI cut-off points and ideal body fat percentages such as these from the American Council on Exercise. Pulmonary function tests (FVC, FEV1, PEFR and FEV1/FVC ratio) were performed using micro-plus spirometer. Maximal expiratory pressure (MEP) was measured using Respiratory pressure meter. Statistical analyses were performed using the SPSS.
Results: The mean of MEP was significantly higher in obese subjects ($p<0.032$). The mean FEV1/FVC% was significantly higher in obese subjects ($p<0.00$) but FEV1, FVC and PEFR values were not significantly different. A significant positive correlation was found between MEP and BMI and body fat% (obesity).
Conclusion: Maximum expiratory pressure was significantly higher in healthy obese subjects, compared to non obese control. possibly due to the increased work of breathing. Positive correlation between MEP and BMI and body fat% was observed.

P2118

Changes of active expiration respiratory muscle (RM) in men with chronic obstructive pulmonary disease (COPD)

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Background: For the present moment changes occurring in RM, during COPD, have been studied insufficiently.
Aim and objectives: to investigate the RM status and compare them with histological data of bioptic muscular material.
Material and methods: The peak histogram of the internal oblique abdominal muscle (intOAM) was detected by ultrasonic scanner. We obtained the indices: homogeneity (H), structural density (SD) and echogenicity (E). Histological research of bioptic material of intOAM has been carried out.
Research was made in 13 pts: 1st group: 8 at the 1st COPD stage; mean age 56 yrs; BMI $24kg/m^2$; 2nd group: 5 at the 2nd COPD stage, mean age 59 yrs; BMI $24kg/m^2$. Control group was formed of 10 healthy subjects compared according to age-, sex- and BMI.

Results: Contractions, small sites of a fragmentation, stratification of myofibrils and proliferation of fibroblasts were observed at the 1st and 2nd COPD stage. We revealed scleroses of single muscular fibril and foci of sclerosis in intramuscular regions. The median H in the 1st and 2nd groups was 21 and 18 units respectively. Increasing severity of COPD was associated with enhancing of contractions and stratification of myofibrils. Thus, we detected the significant correlations between COPD severity and contractions (r=0,72) and with stratification of myofibrils (r=0,66). Indices H and SD were lower in pts with more scleroses manifestations (r= - 0,42 and r= - 0,59). Whereas index E was higher in these patients (r=0,59). The pack/years significantly correlated with intensity of proliferation of fibroblasts (r=0,56).
Conclusions: Indices H, E, SD reflect the pathological processes occurring in RM in COPD patients.

P2119
Acute inspiratory load effects on chest wall volumes distribuition and inspiratory muscles activation
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Inspiratory loads can induce changes on the ventilatory pattern. In order to analyze the acute effect of the imposition of inspiratory load (IL) on the ventilatory pattern and inspiratory muscle action, 39 healthy subjects (19M, 20F) were analyzed. Characteristics of male and female subjects respectively were: age,25.50±0.86 and 22.70±0.45 years, FEV1/FVC, 95.05±2,27 and 105.06±1.97%pred; maximal inspiratory pressure, 123.6±43.7 and 98.2±37.4 cmH_2O. During IL, total and compartmental volumes were measured by Opto-Electronic Pletysmography (OEP) simultaneously with the activity of bilateral sternocleidomastoid (STMD) and Diaphragm (DI) measured by Surface Electromyography (SEMG). For diaphragm SEMG, electrodes were positioned on the 7th e 8th intercostal spaces on anterior axillary line. For STMD SEMG, electrodes were positioned 5 cm below the mastoid process. IL was performed using Threshold®, with 2 minutes of breathing at different levels (initial load=10 cmH_2O, then increments of 5 cmH_2O, up to 40 cmH_2O or exhaustion). Inspiratory time increased during IL compared to Quite Breathing (QB) (p=0.004). Tidal volumes of the total chest wall (Vcw) and pulmonary rib cage (VRcp) increased for loads ≥20 cmH_2O (p= 0.000). Tidal volume of the abdomen increased only for loads ≥at 30 cmH_2O (p= 0.03) in males and ≥20cmH_2O in females. Median frequency of STMD started to decrease for loads ≥30 cmH_2O (p=0.02), while that of the DI decreased only for loads ≥40 cmH_2O (p=0.049). In conclusion, the acute effects of IL in healthy subjects occur before and are more intense on inspiratory rib cage muscles than the diaphragm This behavior should be considered when IL treatments are given to patients.

P2120
Does lung transplantation improve chronotropic incompetence?
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Introduction: Chronotropic Incompetence (CI), or an attenuated heart rate (HR) response to exercise, has been widely established as a predictor of mortality but has not been studied in patients undergoing lung transplantation.
Objectives: We aimed to see whether CI in maximal exercise testing exists in patients with advanced lung disease before lung transplantation and improves after surgery.
Methods: A retrospective review of 153 patients who underwent lung transplantation at Columbia University Lung Transplant Program between 6/2002 and 4/2009. Patients had cardiopulmonary exercise testing (CPET) within 30 months before or after transplant with concurrent with pulmonary function tests (PFT). Exclusion criteria included the use of beta-blockers. Comparisons were made with paired samples t-test.
Results: The mean PFT and CPET variables for the 71 patients (age 50±15 years) analyzed are shown in table 1.

Table 1. Select Pre/Post Transplant Variables

Variable	Pre Transplant	Post Transplant	p-value
BMI	24.17±4.29	25.99±4.38	<0.001
Watts Peak	45±29	84±34	<0.001
VCO2 Peak	0.97±0.47	1.53±0.49	<0.001
HRrest	95±18	89±11	0.008
HRmax	127±21	135±17	0.001
HRRU	44±23%	58±18%	<0.001
Breathing Reserve	27±18%	50±12%	<0.001

Conclusions: Marked CI was observed before lung transplantation and improved afterwards but did not normalize. CI likely improved due to the normalization of pulmonary function post transplant. This was seen through a lower resting HR and a higher maximal HR. The implications of CI are not clear and warrant further investigation, including evaluation of the association of CI and morality after transplant.

P2121
Does chronotropic incompetence occur in interstitial lung disease?
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Introduction: Chronotropic Incompetence (CI) is an attenuated heart rate (HR) response to exercise that has been widely established as a predictor of mortality in general populations and in patients with heart disease. CI has not been studied in patients with interstitial lung disease (ILD) despite abnormalities in pulmonary hemodynamics and cardiopulmonary parameters.
Objectives: Our primary aim was to see whether CI exists in patients with ILD during maximal exercise testing.
Methods: This is a retrospective review of 482 patients with ILD who underwent cardiopulmonary exercise testing (CPET) at Columbia University Human Performance Laboratory between 10/1999 and 2/2011. Patients had CPET with concurrent pulmonary function tests (PFT). Comparisons were made with paired samples t-test.
Results: The mean PFT and CPET variables for the 482 patients (aged 56.6±11.0 years) analyzed are shown in table 1. Usual heart rate reserve used (HRRU) is 85% in normal subject populations.

Mean PFT and CPET variables for the 482 ILD patients

Variable	Mean ± SD
BMI	26.2±4.6
Watts Peak % predicted	42.2±22.5%
VCO2 Peak	1.26±0.54
HRrest	89±16
HRmax	125±20
HRRU	49±24%
Breathing Reserve	42±17%

Conclusions: Marked CI was observed in patients with interstitial lung disease in a large cohort. This abnormality may have implications for long term survival as cardiac mortality and cardiac comorbidity are common as ILD progresses with possible development of pulmonary hypertension and right heart failure. Further investigation with assessment of mortality risk and possible identification of interventions to improve CI may help to improve outcomes in this patient population.

P2122
Effect of posture on chest wall and diaphragm asynchronies in COPD
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In COPD hyperinflation alters the function of the inspiratory muscles. The zone of apposition of the diaphragm (ZOM) is reduced, thus COPD patients often show paradoxical movement of the lower rib cage. The aim of this study is to investigate if in COPD chest wall and diaphragm asynchronies are altered by posture.
24 severe COPD (FEV_1=32.5±7.0%pred) and 12 age-matched controls (CTR) (FEV_1=111.1±16.2) were studied during quiet breathing in seated (ST) and supine (SP) positions. Phase shift (θ) between pulmonary rib cage (RCp) and abdominal rib cage (RCa) and θ between RCp and the abdomen (AB) were assessed by opto-electronic plethysmography.The cranio-caudal displacement of the ZOM (ΔZOM) was contemporarily measured by ultrasonography.
Neither θ between RCp and RCa or θ between RCp and AB was altered by posture in CTR. Conversely, in COPD patients, θ between RCp and RCa decreased when changing posture from ST to SP (θ=23.7°±19.5, θ=5.2°±18.1 respectively, p<0.001).RCp and AB in COPD showed a behavior similar to CTR while in ST (θ=1.3°±13.3 in COPD, θ=0.1°±4.5 in CTR), but strongly differed in SP (θ= -25.0°±18.2, p<0.001; p<0.01, COPD vs. CTR).Moreover, in COPD ΔZOM was linearly correlated to RCp in ST (r^2=0.718±0.140), similarly to control subjects (r^2=0.729±0.150), while it was significantly less correlated to RCa (r^2=0.510±0.246, p<0.01).In COPD correlation between ΔZOM and both RCp and RCa decreased (r^2=0.530±0.244, r^2=0.511±0.230 p<0.05) in SP.
In COPD the diaphragm and RCa are uncorrelated in ST, but the synchronous action of the rib cage muscles and the diaphragm is similar to healthy. In SP the diaphragm is uncorrelated with both RCp and RCa, so the asynchrony with the rib cage muscles seems to be pronounced.

P2123

Parasternal muscle contractility increases with aminophylline

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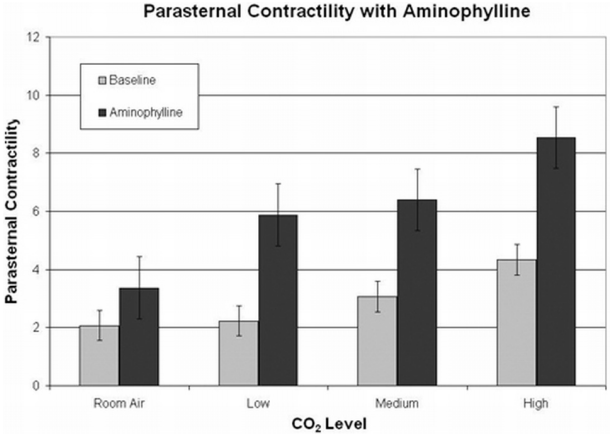
Introduction: The traditional theophylline bronchodilator, Aminophylline, is still widely used, especially in the treatment of COPD. However, in COPD patients the effects of theophylline have been inconsistent. Recently, Aminophylline was shown to increase ventilation and costal diaphragm contractility in awake canines (Jagers et al. Resp. Phys. 2009;167:273-280).

Aim: To investigate the effect of Aminophylline at therapeutic levels on the primary chest wall muscle, Parasternal Intercostal.

Methods: Sonomicrometry transducers and EMG electrodes were implanted in the left parasternal muscle. After recovery, the animals were studied awake, unanesthetized and breathing through a snout mask; air flow, $ETCO_2$, heart rate, muscle length and shortening, and moving average EMG were recorded during room air, and CO_2 stimulated ventilation, before and after loading and continuous infusion of Aminophylline at therapeutic levels.

Results: For N=5 dogs (mean 31.1 kg) 24 days post implantation. Aminophylline serum levels were 66.4 umol/L (therapeutic range 55-110). Minute ventilation increased significantly with Aminophylline: 6.7, 7.84, 11.8 and 16.6 L/min at room air, low (46), medium (52) and high (57 mmHg) CO_2 stimulated breathing respectively. Parasternal contractility increased significantly.



Conclusion: Parasternal muscle contractility increases with greater muscle shortening per EMG, in awake, intact canines, at therapeutic levels of Aminophylline.