504. Innovative methods in clinical physiology

Ori Adam1, Robert Shiner 2 , Peter Calverley3, Julian Solway4 , Robert Brown5, The measurement of absolute lung volume without plethysmography

Elastase-induced emphysema in rodents is characterized by enlarged alveoli and decreased lung elastance but generally no change in airway resistance. We studied airway and tissue mechanics and recruitment in rats before and during constrictor challenge. Sprague-Dawley rats were treated by intratracheal instillation of 50 μl porcine pancreatic elastase (PPE, n=6). Three weeks later, these animals and 6 controls (C) were anesthetized, tracheotomized and mechanically ventilated. From low-frequency impedance (Zrs), tissue damping (G), elastance (H) and hysteresivity (αf) were calculated. The lungs were degassed in vivo with oxygen breathing (10 min) and tracheal occlusion (10 s), and then reinflated to 35 hPa, while the pressure-volume (PV) relationship and intratracheal crackle sound (Cra) were recorded. Measurements of Zrs, PV and Cra were repeated during i.v. infusion of methacholine (Mch) at 53 μg/kg/min. RN was not different between groups PPE and C at baseline (44±4 vs 46±10 hPa/l) and during challenge (165±4 vs 163±17 hPa/l). G and H, respectively, were significantly lower in the PPE group compared to the controls (613±83 vs 889±165 hPa/l, and 2273±301 vs 3033±385 hPa/l), although their elevations due to Mch were similar (71±13 vs 79±34% for G, and 24±13% vs 25±20% for H). Whereas cumulative crackle intensity reached 80% at similar P levels in both groups, the recruited volume was more reduced during challenge (-39 vs -16%) in the PPE group. In summary, while airway resistance and recruitment remained unaffected, the tissue damage was associated with an enhanced tissue constrictor response following elastase treatment.

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Late-breaking abstract: Lung recruitment in normal and emphysematous rats during methacholine challenge

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Elastase-induced emphysema in rodents is characterized by enlarged alveoli and decreased lung elastance but generally no change in airway resistance. We studied airway and tissue mechanics and recruitment in rats before and during constrictor challenge. Sprague-Dawley rats were treated by intratracheal instillation of 50 μl porcine pancreatic elastase (PPE, n=6). Three weeks later, these animals and 6 controls (C) were anesthetized, tracheotomized and mechanically ventilated. From low-frequency impedance (Zrs), tissue damping (G), elastance (H) and hysteresivity (αf) were calculated. The lungs were degassed in vivo with oxygen breathing (10 min) and tracheal occlusion (10 s), and then reinflated to 35 hPa, while the pressure-volume (PV) relationship and intratracheal crackle sound (Cra) were recorded. Measurements of Zrs, PV and Cra were repeated during i.v. infusion of methacholine (Mch) at 64 μg/kg/min. RN was not different between groups PPE and C at baseline (44±4 vs 46±10 hPa/l) and during challenge (165±4 vs 163±17 hPa/l). G and H, respectively, were significantly lower in the PPE group compared to the controls (613±83 vs 889±165 hPa/l, and 2273±301 vs 3033±385 hPa/l), although their elevations due to Mch were similar (71±13 vs 79±34% for G, and 24±13% vs 25±20% for H). Whereas cumulative crackle intensity reached 80% at similar P levels in both groups, the recruited volume was more reduced during challenge (-39 vs -16%) in the PPE group. In summary, while airway resistance and recruitment remained unaffected, the tissue damage was associated with an enhanced tissue constrictor response following elastase treatment.

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The measurement of absolute lung volume without plethysmography

Ori Adam1, Robert Shiner 2 , Peter Calverley3, Julian Solway4 , Robert Brown5, The measurement of absolute lung volume without plethysmography

A basic and important component of pulmonary function testing is determination of the functional residual capacity (FRC) and total lung capacity (TLC). These measurements are usually obtained in 4 axial slices during inhalation of 70% Xe in O2. Regional iodine deposition images were obtained in 45 contiguous slices after 5, 10, 15 and 20 minutes of nebulization. Results: See figure. Aerosol deposition showed significant spatial heterogeneity in normal lung. Inset: 3D rendering of central conducting airways (dark) and iodine (medium) and parenchyma (light grey).

Rationale: The simultaneous measurement of regional lung ventilation, aerosol deposition and the anatomic configuration of airways are crucial for the better understanding of the determinants of aerosol deposition heterogeneity. However, no single imaging modality currently allows the acquisition of all such data simultaneously. The goal of this study was to test the feasibility of KES imaging to this end.

Methods: We used KES synchrontron radiation imaging (ARJCC, 2009;180:296–303) to quantify regional lung ventilation, and the deposition of iodine (isopropyl 88 mg/ml in NaCl 0.9%), delivered using an ultrasonic nebulizer (mass median aerodynamic diameter: 2.6±0.1 μm), in a healthy anesthetized, and mechanically ventilated rabbit (2.8 kg) in upright position. Regional ventilation images were obtained in 4 axial slices during inhalation of 70% Xe in O2. Regional iodine deposition images were obtained in 45 contiguous slices after 5, 10, 15 and 20 minutes of nebulization.

Results: See figure. Aerosol deposition showed significant spatial heterogeneity in normal lung. Inset: 3D rendering of central conducting airways (dark) and iodine (medium) and parenchyma (light grey).
In conclusion, OI3 is characterized by rib cage deformities (pectus carinatum) which alters CW function during breathing. The reduced or paradoxical rib cage motion during inspiration is compensated by an increased action of the diaphragm which alters CW function during breathing. The reduced or paradoxical rib cage motion during inspiration is compensated by an increased action of the diaphragm which alters CW function during breathing.

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Diaphragm fatigue in self-paced running exercise of different durations

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Introduction: Diaphragm fatigue (DF) was shown to develop during high intensity constant-load exercise (CLE) above 85% of maximal oxygen consumption (VO2max). DF cle does, however, not appropriately reflect field trial conditions where exercise intensity is regulated by complex feedforward and feedback mechanisms, possibly aiming to reduce/prevent DF. Therefore, the development of DF was assessed in 11 well-trained athletes (age=31±4 yrs, VO2max=66±4.6 ml/min·kg-1) in 15 and 30min running time trials (TT). We hypothesized that DF would be larger in the 30TT where more time is spent above 85%VO2max.

Methods: Before and 4min after completion of the TTs, esophageal and gastric pressures were assessed to calculate transdiaphragmatic twitch pressures (Pdi,tw) during cervical magnetic stimulation.

Results: All subjects developed DF (Pdi,tw reduction, ΔPdi,tw >10%) in the 15T and 7/11 subjects in the 30TT. On average, ΔPdi,tw was 23±6.5 (15T) and 18.5±12.1% (30TT; p=0.13). Mean exercise intensities were 89.4±3.5 (15T) and 80.6±3.7%VO2max (30TT; p=0.07) with similar mean durations above 85%VO2max (11.9±2.0min; range: 7-14min, 15T) and (16.2±5.7min, 1-28min, 30TT; p=0.19). The individual between-TT difference in ΔPdi,tw did not correlate with the difference in time spent above 85%VO2max (R2=0.20) but correlated with the difference in average exercise intensity above 85%VO2max (R2=0.49; p=0.02).

Conclusion: In TT-conditions, the degree of DF is not related to the duration spent above 85%VO2max but it is related to the exercise intensity when exercising above the 85%VO2max-threshold.
is not sufficiently high to replace P50t in the evaluation of individual patients with suspected disturbances of hemoglobin oxygen affinity.