EUROPEAN SYNCHROTRON RADIATION FACILITY

INSTALLATION EUROPEENNE DE RAYONNEMENT SYNCHROTRON

Experiment Report Form

ESRF	**Experiment title:** Imaging the within-tidal changes in regional lung function in Acute Respiratory Distress Syndrome	**Experiment number**:
Beamline: ID17	**Date of experiment**: from: 03 May 2018 to: 09 May 2018	**Date of report**: 28 Feb 2020
Shifts: 15	**Local contact(s)**: Alberto Bravin (email: bravin@esrf.fr) Herwig Requardt (email: requardt@esrf.fr)	*Received at ESRF:*

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Report:

Rationale and objectives: Mechanical ventilation, a crucial means of life support during acute respiratory failure or routine anaesthesia, can cyclically affect the regional distribution of blood volume in normal lung. Despite the importance of dynamic changes in the regional distributions of gas and blood during the breathing cycle for lung function in the mechanically ventilated patient, until recently no quantitative data on such cyclic changes were available. We recently introduced a modification of the K-edge subtraction CT (KES) that allows to quantitatively analyse regional lung ventilation, blood volume, and tissue structure at sub-acinar spatial resolution (1-3) within the breathing cycle. Using this technique, we demonstrated for the first time, cyclic variations in regional pulmonary blood and gas volume distributions during a single respiratory cycle (MD-679). The quantitative matching of regional gas and blood volume tidally oscillated, suggesting a potential link between cyclic changes in regional gas and blood distribution and previously-described oscillations in arterial blood O_2 partial pressure (PaO_2), under controlled ventilation (4). In a previous experiment (MD-1042) we used a novel approach to record within-tidal oscillations in PaO_2 using a fast fiberoptic indwelling O_2 probe during imaging. We successfully acquired simultaneous dynamic imaging and online PaO_2 measurements in 5 controls, but due to technical difficulties, only in 3 animals with ARDS. **This proposal was a continuation of MD-1042 and aimed at assessing the relation between the cyclic changes in pulmonary blood volume during the breathing cycle and its link to tidal gas exchange,** in an experimental model of **ARDS** in rabbit. Specifically, our aim was to complete the number of experiments for

sufficient statistical power to demonstrate for the first time, the relation between within-tidal pulmonary blood volume oscillation and that of PaO_2.

Methods: K-edge subtraction imaging (8) was performed on ID17, successively at 34.56 and 33.17 keV, using a liquid nitrogen-cooled Ge detector, allowing for continuous tomographic acquisitions at 350 µm pixel resolution over 2-3 min. The experimental setup is available and has been extensively used in previous experiments since 2001. Pending approval by the ethics review board, the experiments will be performed in one group of 8 anesthetized, tracheostomized, 3 kg New Zealand White rabbits (control, after lavage + endotoxin-induced lung injury, a model of ARDS). Anaesthesia was be induced by IM ketamine + xylazine and maintained using IV ketamine + xylazine + fentanyl. A commercial patient ventilator (Maquet Servo-i) was be used. A fiberoptic, fluorescence-quenching oxygen probe (FOXY-AL300; Ocean Optics) was placed in the thoracic aorta through the carotid artery for fast PaO_2 monitoring. Animals were euthanized by IV sodium thiopental overdose at the end of the experiment.

Results: Dynamic images of the regional distribution of gas (Xe) and blood volume (Iodine) were obtained at baseline and after surfactant depletion and injurious-ventilation induced ARDS in 8 animals. Data are fully reconstructed and are currently still being analyzed and compared to the O2 probe data. Sample data are presented in Figure 1.

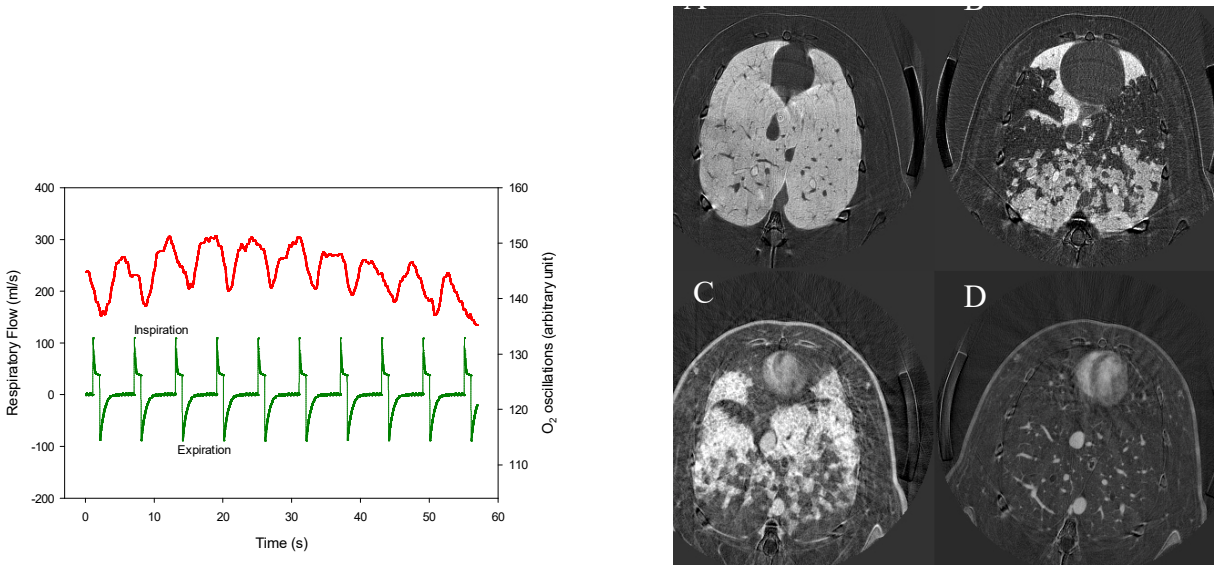

Figure 1. Left: B: *Within-tidal oscillations in PaO_2 (red) and respiratory flow (green) from our previous experiment (MD-1042), similar data have been acquired during the present experiment; Right: Distribution of gas (Xe; A, B) and blood volume (Iodine; C, D) at baseline and after acute lung injury, respectively.*

Conclusions: The experiment was successful in acquiring the necessary data that will allow reconstructing dynamic maps of within-breath changes in regional lung gas and blood volume distributions, both in healthy lung and in follwing induction of acute lung injury. Since this is a time-consuming analysis, the present is a preliminary report. However, given the quality and quantity of obtained data, we expect to fulfill the main objectives of the study.