Characterization with EIT of regional ventilation distribution in experimental lung injury induced by unilateral ligation of the pulmonary artery

Ines Marongiu[1], Elena Spinelli [2], Eleonora Scotti [2], Alessio Caccioppola [1], Gaia Dal Santo [1], Virginia Figgiaconi [1], Erica Garbelli [1], Anna Damia [1], Chiara Magri[1], Davide Calabretta [1], Giorgio Giudici [1], Carolina Negro [1], Osvaldo Biancolilli [2], Michele Battistin[3], Caterina Lonati [3], Valentina Vaira [4, 5], Gianluca Lopez [4, 5], Francesco Damarco [6], Carla Fornari[7], Lorenzo Rosso [6, 8], Stefano Ferrero [4, 5], Stefano Gatti [3], Alberto Zanella [1,2], Tommaso Mauri[1,2]

1. Department of Pathophysiology and Transplantation, University of Milan, Italy; 2. Department of Anesthesia, Critical Care and Emergency, Fondazione IRCCS Ca' Granda Ospedale Maggiore Policlinico, Milan, Italy; 3. Center for Preclinical Research, Fondazione IRCCS Ca' Granda, Ospedale Maggiore Policlinico, 20019 Milan, Italy; 4. Department of Biomedical Surgical and Dental Sciences, University of Milan, Italy; 5. Division of Pathology, Fondazione IRCCS Ca' Granda Ospedale Maggiore Policlinico, Milan, Italy; 6. Department of Thoracic Surgery and Lung transplants, Fondazione IRCCS Ca' Granda Ospedale Maggiore Policlinico, Milan, Italy; 7. University of Milano-Bicocca, School of Medicine and Surgery, Monza, Italy; 8. Department of Health Science, University of Milan, Italy

Introduction

Ligation of the left pulmonary artery in healthy pigs is associated with bilateral lung injury which might be prevented by inhaled CO_2. Mechanisms involved remain elusive.

Objectives: To study regional ventilation distribution in a model of unilateral ligation of the left pulmonary artery with and without administration of inhaled CO_2.

Model: LEFT PULMONARY ARTERY LIGATION

Groups: 11 pigs ventilated for 48 hours

4 Ligation group: Vt 10 ml/Kg, PEEP 5 cmH_2O, 25 bpm, FiO_2 50%

7 Ligation + $FiCO_2$ 5% group: Vt 10 ml/Kg, PEEP 5 cmH_2O, 25 bpm, FiO_2 50%, $FiCO_2$ 5%.

Measures at 2, 12, 24, 36 and 48 hours from artery ligation:

- Distribution of ventilation measured by electrical impedance tomography

Measures at the end of the experiment:

- Histological score
- Respiratory mechanics
- Gas exchange

Results

At the end of the experiment animals in the Ligation group developed bilateral lung injury while inhaled CO2 prevented it (Table 1).

	Ligation + $FiCO_2$ 5% (n=7)	Ligation (n=4)	P value
Compliance (mL/cmH_2O)	40 [31; 44]	24 [18; 26]	0.006
Plateau Pressure (cmH_2O)	14 [13; 16]	23 [21; 29]	0.006
PaO_2/FiO_2	520 [384; 542]	298 [141; 391]	0.039
Histological score	4 [3; 4]	8 [8; 10]	0.006

Table 1. Data are expressed as median [quartiles]. Comparisons are obtained with Mann-Whitney test.

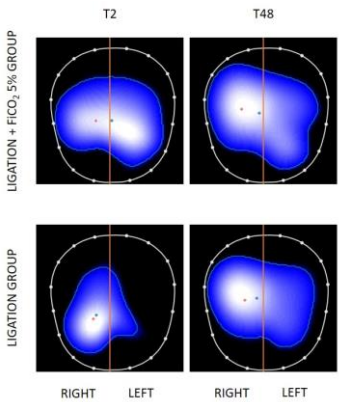

Figure 1. Distribution of ventilation by EIT at T2 and T48

We studied distribution of ventilation by EIT as possible mechanism for contralateral lung injury (Figure 1).

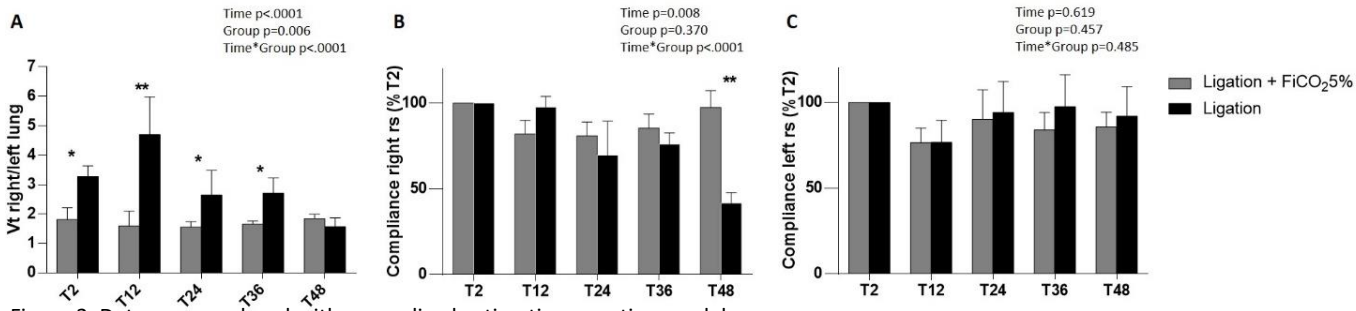

Figure 2. Data were analyzed with generalized estimating equation models.

The Ligation group showed higher fraction of Vt reaching the right perfused lung (Fig. 2A) from T2 to T36 compared to the Ligation + FiCO2 5% group. At T48, right and left lungs were subject to a more equal distribution of Vt, probably due to a fall in right lung compliance (Fig. 2B), consistent with development of lung injury in the perfused lung.

Conclusions

Redistribution of Vt to the perfused lung may be implied in the development of regional lung injury following ligation of contralateral pulmonary artery. Mechanisms inducing injury in the non-perfused lung remain to be elucidated.