

Lung recruitability and prone position in late COVID-19 pneumonia

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Introduction

- We investigate the anatomic-physiological mechanisms of the response to prone position and to lung recruitment maneuver, in late COVID-19 pneumonia.

Materials and methods

- 12 patients with COVID-19 pneumonia (mean age of 60.2 ± 9.0 , and average time between admission to the hospital and the study of 13.7 ± 6.7 days), underwent three CT lung scan, in three experimental steps, whose sequence was randomized: supine, prone, and supine position, at 5, 5, and 35 cmH₂O, respectively (supine-5, prone-5 and supine-35).
- Gas exchange, lung mechanics and quantitative lung CT analysis (on whole slice and on ten equally spaced segments along the sterno-vertebral axis) were measured at each step. We defined as consolidated tissue, the non-aerated one in supine-35, and atelectatic tissue, the one that regain aeration at 35 cmH₂O.

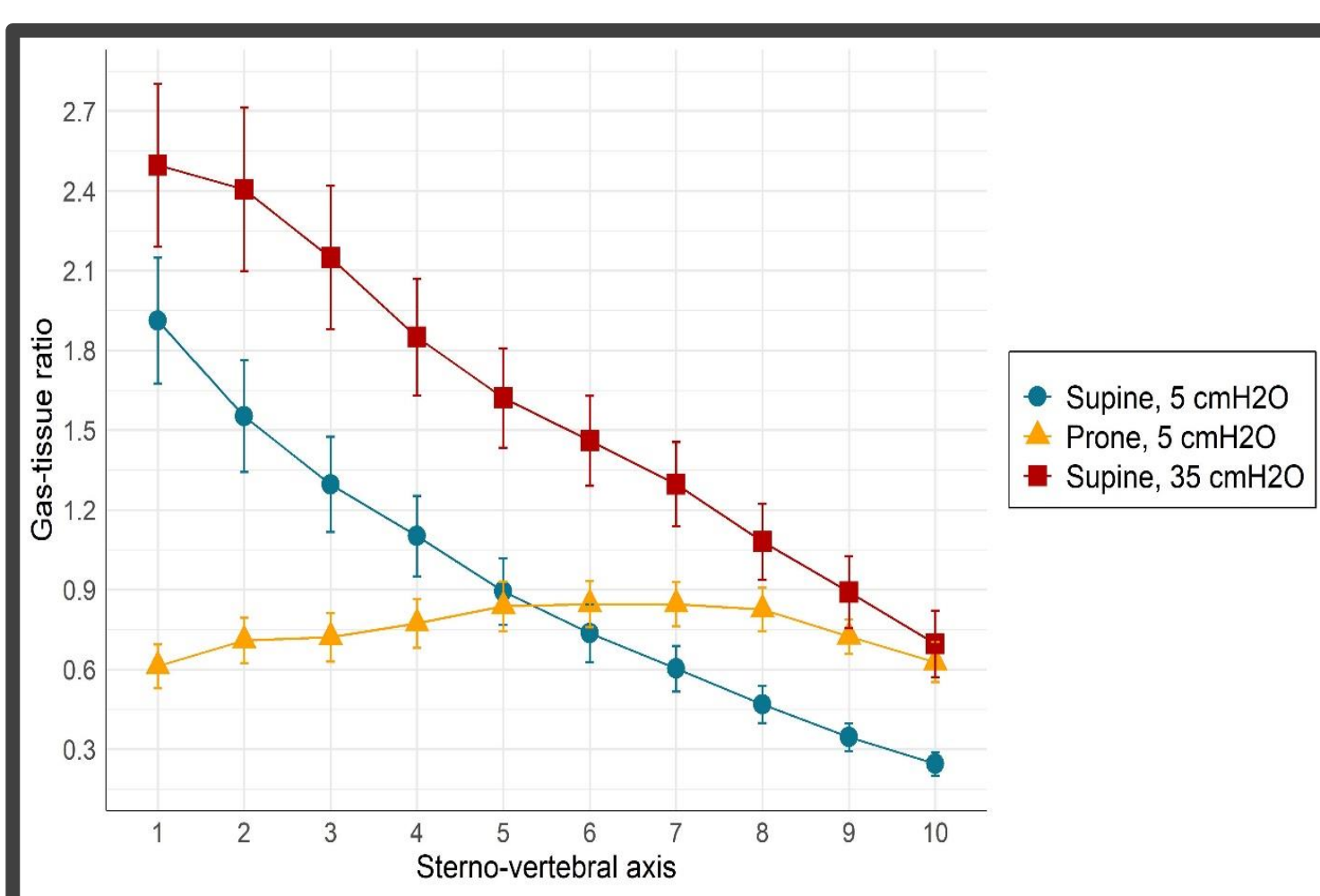
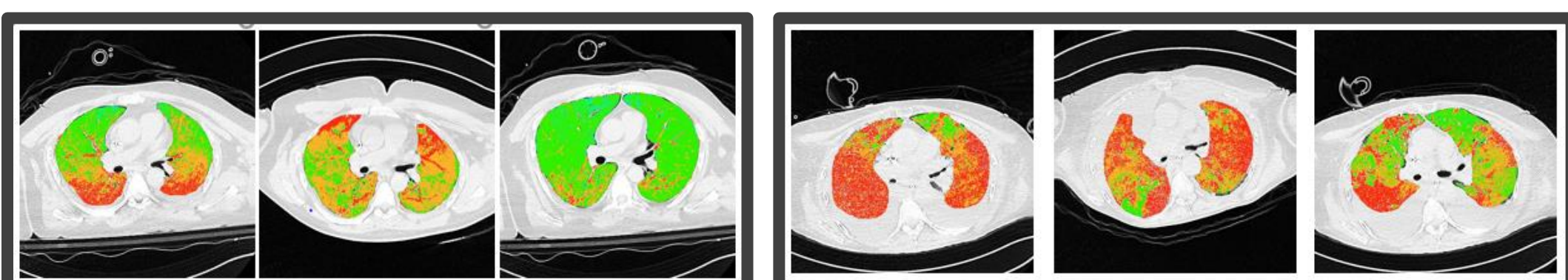


Fig.1: Gas-tissue ratio distribution along the sterno-vertebral axis in supine-5, prone-5 and supine-35. In contrast, in prone-5, the “acinus” present similar dimensions from sternum to the vertebra. This reflects the more homogenous stress and strain distribution in prone-5 compare to supine.

Fig.3: Examples of overlays at CT scan of two different patients: in green, the well aerated tissue, in red, the non aerated tissue



Recruitable patient
(Recruitment fraction 39.9%)

Non recruitable patient
(Recruitment fraction 0,07 %)

Aknowledgments

This poster was possible because of the work of Sandra Rossi, Luisa Caspani, Nicola Sverzellati, Malchiodi Laura.

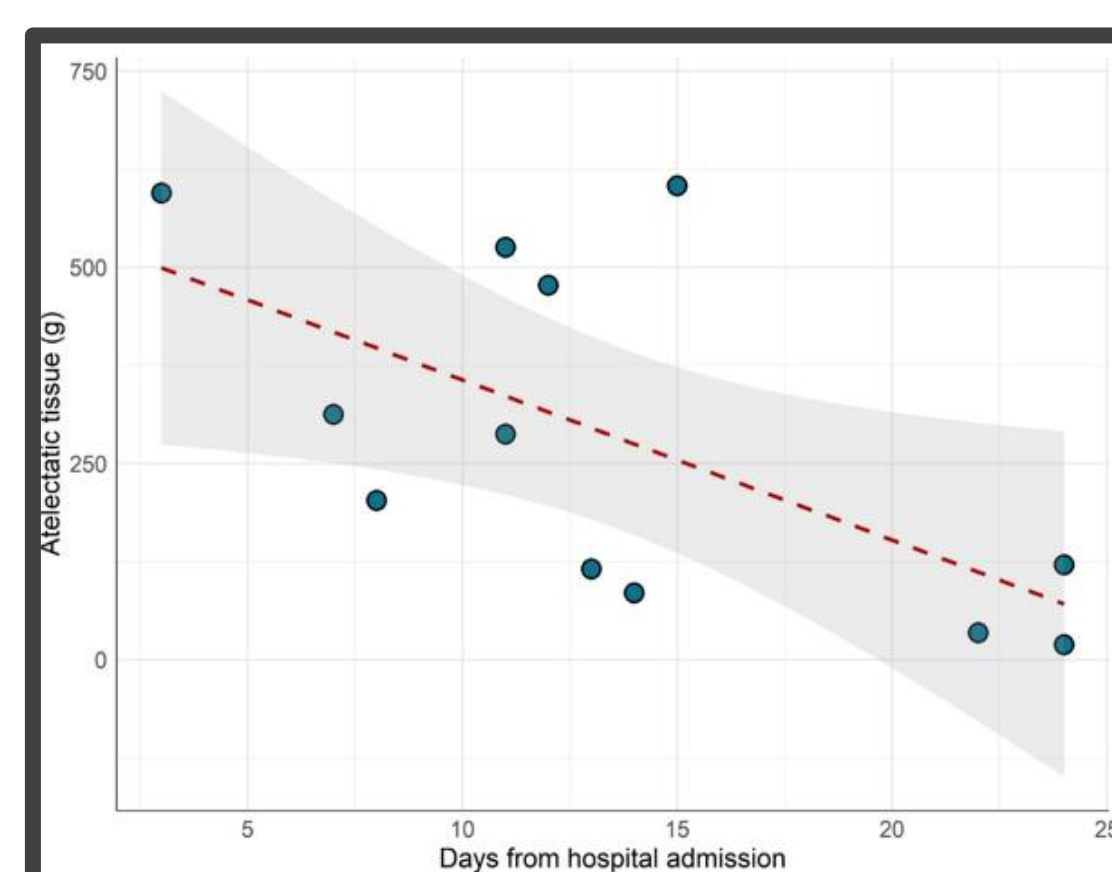
This work was founded by Professor L.Gattinoni, Sandra Rossi, Luisa Caspani, Nicola Sverzellati

Results

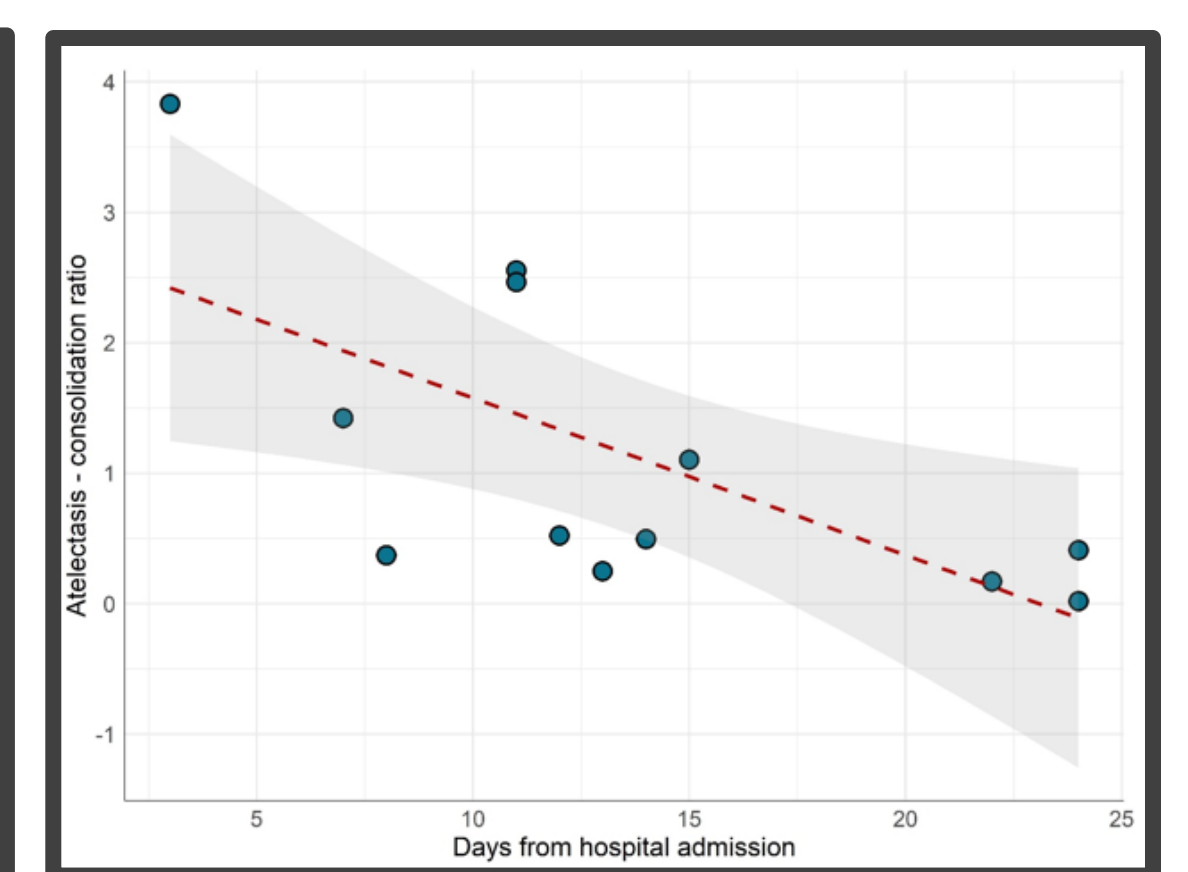
- By definition, the consolidated tissue was identical in the three steps; the atelectatic tissue was slightly but not significantly lower in supine and prone-5 ($32.7 \pm 23.9\%$ vs $42.1 \pm 23.9\%$ respectively, with a $p=0.35$).
- The atelectasis in ventral regions increased from 25.8 ± 27.1 to $65.2 \pm 23.4\%$, shifting from supine to prone, while decreased from 42.5 ± 24.9 to $10.4 \pm 29.0\%$, in dorsal regions. The atelectasis redistribution led to a greater homogeneity of the gas/tissue ratio through the whole lung (Fig.1).
- Although the lung weight did not change with time, the fraction of the atelectatic tissue on total lung weight, and the ratio between atelectasis and consolidation, decreased significantly with the increase in time elapsed between the hospital admission and the study day (Fig.2):
 - Atelectatis% = $-0,01 \times \text{days} + 0,36$ ($p=0.01$, $R^2=0.43$);
 - Atelectasis/Consolidation Ratio = $-0.11 \times \text{days} + 2.7$ ($p=0.018$, $R^2=0.38$).
- Similarly, the lung gas volume and the respiratory system compliance, decreased with time ($R^2=0.48$, $p=0.007$, and $R^2=0.34$, $p=0.027$, respectively).

Fig.2: Change of atelectatic tissue (Panel A) and its ratio to consolidated tissue (Panel B) as a function of time. Over the course of the disease, the amount of atelectatic/recruitable tissue, and its ratio to consolidated tissue decreases.

Panel A



Panel B



Conclusion

- Response to lung recruitment maneuver and to prone position was highly variable, and primarily dictated by the underlying pathology (atelectasis vs consolidation) (as shown for two different patients in the Fig.3), which was related to the time course of the disease