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Influence Of Chest Wall On Lung Mechanics During Inspiration

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RATIONALE: The interaction between lungs and chest wall influences lung volume, that determines lung history during respiration cycle. In this study, the influence of chest wall mechanics on respiratory system is assessed by the evaluation of inspiration pressure-volume curve (PV curve) under three different situations: closed-chest, open-chest and isolated lung. The PV curve parameters in each situation allow us to further understand the role played by different chest wall elements in the respiratory function.
Methods: Twenty-four male Wistar rats (236 ± 29 g) were used. The animals were weighted and then anesthetized with xylazine 2% (0,5mL/kg) and ketamine 10% (0,9mL/kg), exsanguinated and later tracheostomized with a metallic cannula (14 gauge). The cannula was connected to an automatic small animal insufflator. This setup was connected to a pressure transducer (32 samples/s). The 24 animals were randomly separated in three groups: (i) closed chest, (ii) open chest and (iii) isolated lung. The rats were insufflated with 20mL quasi-statically (constant speed of 0,1mL/s). Insufflated volume and measured pressure data were kept and PV curves were obtained for all animals. The PV curves were fitted (non-linear least squares) against the sigmoid equation (1) to obtain the sigmoid equation parameters (**a**,**b**,**c**,**d**). Elastance measurements were obtained from linear regression of pressure/volume measurements in a 0,8s interval before and after the calculated point.
Results: The parameters **a**, **b** and **c** showed no significant change, but the parameter **d** showed a significant variation among the three groups. The initial elastance also varied between open and closed chest, indicating the need of a higher pressure for the lung expansion, as can be seen in Table 1.
Table 1: Mean and Standard Deviation of parameters obtained for each protocol

Protocol	a (mL)	b (mL)	c (cm H_2O)	d (cm H_2O)	r^2** (%)	Initial Elastance* (cm H_2O/mL)	Weight (g)
Closed Chest	- 0.35 ± 0.33	13.93 ±0.89	21.28 ± 2.37	6.17 ± 0.84	99.4 ± 0.14	12.72 ± 6.66	232.33 ± 5.72
Open Chest	0.01 ± 0.28	14.79 ±0.54	19.47 ± 1.41	3.50 ± 0.28	98.8 ± 0.34	28.68 ± 2.36	217.33 ± 7.97
Isolated Lung	-0.09 ± 0.46	14.22 ±0.75	21.76 ± 1.43	4.24 ± 0.50	98.9 ± 0.19	7.13 ± 8.85	224.33 ± 16.66

* Elastance measures in the 0-0,1 mL range.

** Goodness of sigmoid fit versus measured data

Conclusion: A supporting effect of the chest wall was observed at the initial moments of inspiration, observed as a higher initial elastance in open chest situations than in closed chest situations (p=0,00001). The similar initial elastance for the isolated lung and closed chest may be explained by the specific method used for the isolated lung experiment. As the isolated lung is supported by the trachea vertically, the weight of the tissue may have a similar effect of the residual negative pressure in the thorax, responsible for maintaining the residual volume.

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