

Changes in lung aeration and venous admixture with higher PEEP in COVID-19 related ARDS: a CT scan study

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Introduction

Venous admixture reflects the perfusion of the anatomical shunt and of low ventilation/perfusion areas. With lung recruitment venous admixture should decrease unless other mechanisms drive perfusion away from already open lung regions. The aim of this study was to describe the change in venous admixture and lung morphology with an increase in positive end-expiratory pressure (PEEP) in COVID-19 related acute respiratory distress syndrome (C-ARDS).

Methods

We studied 32 patients with laboratory confirmed C-ARDS, deeply sedated and paralyzed, within 3 days of intubation. After a recruitment maneuver, a PEEP trial was performed in 15 patients from PEEP 5 to 15 cmH₂O, and in 17 patients from PEEP 10 to 15 cmH₂O. Venous admixture was measured from arterial and central venous blood using Riley's formula. A static lung CT scan at end expiration was taken at those same PEEP levels (5 and 15 or 10 and 15 cmH₂O). Recruitment and hyperinflation were defined as a decrease in non-aerated lung volume (density > -100 Hounsfield Units, HU), and an increase in hyper-inflated lung volume (density < -900 HU), respectively.

Results

Venous admixture decreased from 36 [23-42]% at lower to 30 [23-35]% at higher PEEP ($p=0.014$). In 10 (31%) patients it *increased* (i.e. worsened) at higher PEEP, on average by 3 [3-5]%. Patients with venous admixture worsening at higher PEEP had a larger increase in hyperinflated lung volume compared with patients with venous admixture improving (Table 1). Hyperinflation was larger than recruitment in 5/10 (50%) patients in the "worsening" group vs 3/22 (14%) patients in the "improving" group ($p=0.02$).

Conclusions

In C-ARDS the change in venous admixture with an increase in PEEP is variable. In a subset of patients, venous admixture worsens at higher PEEP, possibly due to hyperinflation of some lung units.

Table 1

		Improving venous admixture	Worsening venous admixture	p-value
Non-aerated lung volume, mL	Low PEEP	357 [257; 473]	411 [355; 551]	
	High PEEP	277 [146; 368]	296 [278; 458]	
	Delta (high – low)	109 [59; 167]	88 [64; 119]	0.49
Hyper-inflated lung volume, mL	Low PEEP	46 [15; 150]	335 [186; 416]	
	High PEEP	143 [79; 334]	491 [313; 710]	
	Delta (high – low)	77 [46; 142]	155 [99; 348]	0.02