Performance of a revised capnodynamic method during lung injury

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Introduction

A capnodynamic method effectively calculates pulmonary blood flow (CO_{EPBF}) using an automatic hold in three out of nine breaths during mechanical ventilation. In a previous study, the performance of the capnodynamic method was affected during lung injury (LI) when using inspiratory holds¹. Revision of the method with expiratory holds inserted into the breathing pattern has shown better performance during hemodynamic changes in normal lungs with low shunt fraction². The aim of the current study was to evaluate the revised CO_{EPBF} during acute lung injury with high shunt fractions.

Methods

Ten pigs were submitted to severe LI with lavage and subsequent ventilator induced lung injury. Effective pulmonary blood flow was calculated with CO_{EPBF} and compared to a reference method for cardiac output, an ultrasonic flow probe placed around the pulmonary artery trunk (CO_{TS}) at (1) baseline with PEEP 5 cmH₂O (BAS_{P5}), (2) LI with PEEP 5 cmH₂O (LI_{P5}) and (3) LI with optimal PEEP (LI_{POpt}), range 10-16 cmH₂O using an open lung tool recruitment. Cardiac output changes were enforced during steps 2 and 3 to estimate trending.

Results

Lung injury and PEEP resulted in significant changes in shunt and PaO_2/FiO_2 index (PFI). Bias (levels of agreement) changed from 0.5 (-0.6 to 1.6) L/min and mean error (ME) 30% at BAS_{P5} to -0.7 (-2.6 to 1.2) L/min and ME 43% during LI_{P5} and finally 1.3 (0.0 to 2.6) L/min and ME 36% after LI_{POpt} . Concordance was 89 and 90% during LI_{P5} and LI_{POpt} .

Condition	CO_{EPBF} (L/min)	CO_{TS} (L/min)	Shunt (%)	PFI
Baseline PEEP 5	4.0 (0.4)	3.5 (0.4)	10 (2)	383 (48)
LI PEEP 5	3.7 (0.8)	4.4 (0.7)	39 (12)	131 (77)
LI PEEP 5 CAVA	2.4 (0.7)	2.8 (0.5)	31 (17)	128 (93)
LI PEEP 5 DOB	4.6 (0.7)	5.8 (0.8)	42 (8)	137 (52)
LI PEEP Opt	4.8 (0.6)	3.6 (0.4)	9 (3)	492 (59)
LI PEEP Opt CAVA	3.5 (0.5)	3.5 (0.3)	9 (4)	475 (82)
LI PEEP Opt DOB	5.9 (0.7)	4.7 (0.5)	13 (6)	471 (102)

Conclusion

CO_{EPBF} performed acceptably during LI with high shunt fractions using expiratory holds in the breathing pattern and trending remained good. CO_{EPBF} could possibly be used in patients with increased shunt for which clinical studies are pending.

¹ Hällsjö Sander C. Acta Anaesthesiol Scand. 2015 Sep; 59(8): 1022-31. Doi: 10.1111/aas.12559

² Hällsjö Sander C. J Clin Monit Comput. 2016 30(6): 761-69. Doi: 10.1007/s10877-015-9767-7