Dissertation presented at Uppsala University to be publicly examined in Enghoffsalen, University Hospital Entrance 50, Uppsala, Thursday, March 13, 2008 at 13:00 for the degree of Doctor of Philosophy (Faculty of Medicine). The examination will be conducted in English.

Abstract

Suarez Sipmann, F. 2008. Titrating Open Lung PEEP in Acute Lung Injury. A clinical method based on changes in dynamic compliance. Acta Universitatis Upsaliensis. *Digital Comprehensive Summaries of Uppsala Dissertations from the Faculty of Medicine* 313. 52 pp. Uppsala. ISBN 978-91-554-7093-7.

The recognition that supportive mechanical ventilation can also damage the lung, the so called ventilation induced lung injury (VILI), has revived the more than 40 year long debate on the optimal level of PEEP to be used. It is established that the prevention of VILI improves patient outcome and that PEEP exerts protective effects by preventing unstable diseased alveoli from collapsing. Therefore, the term “open lung PEEP” (OL-PEEP) has been introduced as the end-expiratory pressure that keeps the lung open after its collapse has been eliminated by an active lung recruitment manoeuvre. The determination of such an optimal level of PEEP under clinical circumstances is difficult and remains to be investigated.

The aim of this study was to investigate the usefulness of breath by breath monitoring of dynamic compliance (Cdyn) as a clinical means to identify OL-PEEP at the bedside and to demonstrate the improvement in lung function resulting from its application.

In a porcine lung lavage model of acute lung injury PEEP at maximum Cdyn during a decremental PEEP trial after full lung recruitment was related to the onset of lung collapse and OL-PEEP could be found 2 cmH_2O above this level Ventilation at OL-PEEP was associated with improved gas exchange, efficiency of ventilation, lung mechanics and less than 5% collapse on CT scans. In addition, dead space, especially its portion related to alveolar gas changed characteristically during recruitment, PEEP titration and collapse thereby helping to identify OL-PEEP.

The beneficial effects of OL-PEEP on lung function and mechanics was demonstrated in a porcine model of VILI. OL-PEEP improved lung function and mechanics when compared to lower or higher levels prior to or after lung recruitment. By using electrical impedance tomography it could be shown that PEEPs within the range of 14 to 22 cmH_2O resulted in a similar redistribution of both ventilation and perfusion to the dorsal regions of the lung. OL-PEEP resulted in the best regional and global matching of ventilation and perfusion explaining the drastic improvements in gas exchange. Also regional compliance was greatly improved in the lower half of the lung as compared to all other situations.

In ARDS patients OL-PEEP could be identified applying the same protocol. The physiological changes described could now be reproduced and maintained during a four hours study ventilation period in real patients at four study centres.

In conclusion, the usefulness of dynamic compliance for identifying open lung PEEP during a decremental PEEP trial was demonstrated under experimental and clinical conditions. This PEEP should then be used as an essential part of any lung protective ventilation strategy. The impact of ventilating ARDS patients according to the principles described in these studies on outcome are currently being evaluated in an international randomized controlled trial.

Keywords: PEEP, open lung, recruitment, dead space, electrical impedance tomography, ARDS.

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