

Commentary

Recruitment and retention of lung volume

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Abstract

Both a reduction in tidal volume and in alveolar recruitment may be necessary to prevent ventilator-induced lung injury in the management of patients with acute respiratory distress syndrome. The lung collapse associated with endotracheal suctioning produces hypoxaemia, but it also causes de-recruitment, potentially aggravating lung injury. A study conducted by Dyhr and colleagues demonstrates the benefit of lung recruitment manoeuvres after suctioning, which help to improve oxygenation and restore lung volume more rapidly. Although this intervention appears safe and beneficial, the precise role of lung volume recruitment manoeuvres remains to be elucidated.

Keywords acute respiratory distress syndrome, atelectasis, mechanical ventilation, suctioning

One of the most common procedures performed in mechanically ventilated patients is that of endotracheal suctioning. Although most health care workers are aware of the potential risks associated with this procedure, including hypoxaemia and haemodynamic compromise, the potential effects on the pathophysiology of the injured lung are not usually highlighted. The recent literature on the mechanical ventilation of patients with acute respiratory distress syndrome (ARDS) stresses the importance of opening and maintaining the patency of lung units in order to prevent ventilator-associated lung injury. The report from Dyhr and coworkers [1] in the present issue provides an important practical insight into the de-recruitment caused by endotracheal suctioning, and the value of the lung recruitment manoeuvre in reversing these effects.

Since it became generally accepted that high tidal volumes and inflation pressures are injurious to the lungs [2], clinical trials in mechanical ventilation have emphasized pressure and volume limitation [3,4]. However, a potential adverse effect of reduced tidal volume ventilation is loss of functional lung volume, with progressive atelectasis occurring over time [5]. This de-recruitment of lung not only exacerbates hypoxaemia but may also produce further alveolar damage [6]. In fact, it has been demonstrated that the repetitive opening and closing of alveoli that occurs during tidal ventilation may

produce local inflammation, as well as the systemic release of cytokines in the blood, potentially producing multiorgan failure [7].

In the light of these effects of tidal volume limitation, an 'open lung' strategy for mechanical ventilation has been advocated in ARDS [8] to improve hypoxaemia and reduce ventilator-induced lung injury. Recruitment of the lung occurs during tidal ventilation, and sufficient positive end-expiratory pressure can be used to counterbalance the tendency for the alveoli to close. However, not all alveoli are recruited during tidal ventilation in the injured lung because of surface tension and adhesive forces, and higher pressures are needed to reopen collapsed airways [9]. Methods used to recruit the lung include sustained inflation manoeuvres, sighs, high-frequency oscillation and prone positioning [10,11]. A clinical trial of an 'open lung' approach in patients with ARDS demonstrated a benefit over a 'conventional' ventilatory strategy that did not employ pressure limitation or lung volume recruitment [12].

The sustained inflation lung recruitment manoeuvre is a relatively simple and safe intervention for achieving lung volume recruitment [13]. Not all patients with ARDS demonstrate a recruitment response; those at an earlier stage in their disease and with normal chest wall mechanics

derive most benefit [14]. Furthermore, the degree of 'recruitable' lung may vary with disease state. Although the patient with pneumonic consolidation may meet clinical criteria for ARDS (bilateral infiltrates and hypoxaemia), the pathophysiologies of the two states clearly differ. The loss of alveoli in pneumonia is due to consolidation rather than atelectasis from surfactant loss, and is less likely to be recruitable [11].

The small randomized controlled study conducted by Dyhr and colleagues provides clinical evidence of the significant loss of lung volume after endotracheal suctioning and the beneficial effect of a sustained inflation recruitment manoeuvre [1]. The eight patients studied had moderately severe ARDS (lung injury score 2.3–3.3) and were studied early in the course of their disease (they had been ventilated for <7 days). Half of the patients had a 'primary' cause of ARDS (i.e. pneumonia), which may be less responsive to recruitment attempts. Nevertheless, in the group as a whole the manoeuvre was effective in improving oxygenation, lung volume and respiratory system compliance more rapidly than did tidal ventilation and positive end-expiratory pressure alone. Lung recruitment following suctioning appears to be a more physiologically appropriate intervention than the usual approach of providing 100% oxygen during the procedure. In fact, this high inspired oxygen concentration may be counter-productive, tending to produce absorption atelectasis [15].

Although lung volume recruitment manoeuvres have a role to play in ventilatory management of patients with ARDS, this cannot be extrapolated to patients with other lung conditions. Many questions related to this intervention remain unanswered. Do recruitment manoeuvres actually open previously closed lung units? What is the optimal method and frequency for recruitment? Does this intervention improve outcome? A multicentre Canadian randomized clinical trial comparing a pressure limited strategy with and without an 'open lung' approach is currently in progress. The 'open lung' protocol includes lung recruitment manoeuvres after endotracheal suctioning and ventilator disconnects [16]. With this and other studies, the precise value of this intervention may become more clearly defined over the next few years.

Competing interests

None.

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