Editorial

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Application of positive end expiratory pressure during laparoscopic surgery

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Positive-pressure ventilation during general anesthesia is a prerequisite for numerous surgical conditions. Mechanical ventilation is non-physiological and can induce lung injury, although ventilator-induced lung injury may be of minor clinical importance during anesthesia for most patients with healthy lungs. However, growing evidence suggests that lung injury can be initiated by mechanical ventilation with a low tidal volume as well as with a high tidal volume in animal models of healthy lungs [1-4]. These recent data suggest that ventilation strategies to minimize lung stress (e.g., prevention of repeated closure and opening) improve oxygenation and can reduce lung injury during general anesthesia. A previous study demonstrated that atelectasis rapidly develops after the induction of anesthesia with a high oxygen fraction, which can be effectively resolved by a lung recruitment maneuver and subsequent application of a substantial level of positive end-expiratory pressure (PEEP) [5].

Increase in shunt and low ventilation to perfusion after the induction of general anesthesia are due to alterations in the shape and dimension of the thoracic cage, which result in reductions in the functional residual capacity (FRC) and pulmonary compliance and an increase in airway resistance [6,7]. The cephalad movement and reduced activity of the diaphragm in the supine position promote the formation of compression atelectasis in the dependent portion of the lung. In addition, the decreased lung volume increases the ratio of the closing capacity to FRC during general anesthesia, which may increase cyclic alveolar closure and reopening during mechanical ventilation. In particular, the increase in abdominal pressure caused by pneumoperitoneum and the head-down body position during laparoscopic surgery causes an additional cranial shift in the end-expiratory position of the diaphragm and enhances airway closure and atelectasis formation in the dependent lung regions [8].

The application of PEEP is believed to preserve lung structures and decrease cyclic closure and reopening of alveoli [9], although there is insufficient evidence regarding whether intraoperative PEEP improves postoperative mortality and respiratory complications [10]. A previous study found that application of a constant PEEP of 5 cmH_2O improves arterial oxygenation compared with zero end-expiratory pressure during endoscopic robot-assisted radical prostatectomy [11]. Lee et al. [12] also suggested use of different levels of PEEP and that the application of a PEEP of 7 cmH_2O improved arterial oxygenation without excessive peak airway pressure or depression of hemodynamic parameters during endoscopic robot-assisted radical prostatectomy. These results should be interpreted carefully in terms of the application of PEEP in overall laparoscopic surgery because various factors, such as body position during laparoscopic surgery and obesity, may affect respiratory function and arterial oxygenation. Previous studies have shown that pneumoperitoneum could increase arterial oxygen tension despite an increase in atelectasis [13,14], and a PEEP of 10 cmH_2O alone did not improve end-expiratory lung volume or oxygenation during laparoscopic surgery requiring the reverse Trendelenburg position [15]. PEEP alone did not reduce atelectasis or improve oxygenation in morbidly obese patients [16].

The ideal level of PEEP has been thought to exist above the lower inflection point (LIP), which can be obtained from the overall pressure-volume curve; however, the LIP indicates the pressure at which recruitment of the lung begins, not that at

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which lung collapse begins. Although the application of a high airway pressure of 30 cmH_2O can significantly recruit collapsed lung, hyperinflation of the lungs by a vital capacity is need to ensure complete opening of the collapsed lung (airway pressure of 40 cmH_2O in patients of normal weight) [6]. Recently, as one approach to reopen the collapsed lung, a recruiting maneuver (RM) followed by the application of PEEP involving the application of 40 cmH_2O of continuous positive airway pressure for 40 s has been suggested to effectively re-expand the collapsed lung and improve oxygenation and respiratory mechanics in laparoscopic surgery as well as acute respiratory distress syndrome [15,17]. Another lung recruitment method involving high PEEP to reduce RM-induced negative cardiac effects has been investigated in cardiac surgery [18].

These open lung strategies appear to be helpful in terms of reducing the potential for ventilator-induced lung injury as a result of cyclic closing and opening of the lung in the intraoperative period. The development of atelectasis during general anesthesia does not appear to increase perioperative complications in most cases because the deep breathing and coughing encouraged by the medical service team after anesthesia can effectively re-expand collapsed lungs. However, efforts to decrease the formation of atelectasis during general anesthesia may be beneficial because some atelectasis may still exist after the operation and become a site of infection [19]. Taken together, these recent data suggest that adequate PEEP and RM can improve arterial oxygenation and respiratory mechanics during anesthesia.

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