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Individualizing Intraoperative Ventilation: Comment

To the Editor:

We read with great interest the article by Pereira *et al.*[1] in a recent issue of ANESTHESIOLOGY. The authors explore electrical impedance tomography–based determination of an individualized positive end-expiratory pressure level to simultaneously limit both atelectasis and overdistension in mechanically ventilated patients during general anesthesia. While atelectasis is a well-recognized consequence of mechanical ventilation during general anesthesia, some authors previously considered overdistension as a non–clinically significant problem in the operating room.[2] We congratulate the authors for presenting data that challenge this assumption.

However, we feel that the authors omitted proper discussion of the discrepancy between their study and two other recent studies that failed to show a difference in postoperative atelectasis when assessed shortly after extubation.[3,4] While Pereira *et al.* are to be commended for using computed tomography, the reference imaging technique, to assess the amount of atelectasis postextubation, we wonder why the authors have chosen a −200 to +100 Hounsfield units interval to define nonaerated lung. In the reference quoted to explain their methodology,[5] atelectasis was defined as −100 to +100 Hounsfield units, as in numerous other publications.[6–8] To rule out the possibility of a classification bias, the authors should have analyzed their results using the generally accepted reference values for both poorly aerated (−500 to −100 Hounsfield units) and nonaerated (–100 to +100 Hounsfield units) lung. Moreover, they should have reported the degree of atelectasis in square centimeters, as used in their sample size calculation, to eliminate the presumption of a reporting bias. We write to request that the authors report results both in square centimeters, as well as according to the generally accepted Hounsfield units reference values to address these potential biases.

Finally, provided the aforementioned concerns are properly addressed, Pereira *et al.*'s work is a crucial piece of information, as the primary mechanism by which lung protective ventilation is thought to decrease postoperative pulmonary complication is through the successful decrease in postoperative atelectasis.[9] The authors weaned their patients using the pressure-support mode maintaining the same intraoperative positive end-expiratory pressure level contrary to the other studies. Interestingly, weaning using assisted ventilatory modes is seldomly performed in the operating room while it is a commonly performed procedure in the intensive care unit. This cointervention might explain this trial's observed difference in postoperative atelectasis. We would also welcome comments from the authors about their choice of weaning method.

Competing Interests

The authors declare no competing interests.

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Individualizing Intraoperative Ventilation: Reply

In Reply:

We thank Drs. Girard and Carrier for their comments on our study published in Anesthesiology.[1] We agree that overdistension has been overlooked in the operating room. Occurring predominantly in conditions of high positive end-expiratory pressure (PEEP), overdistension is one mechanism through which patients may require higher driving pressures for a given tidal volume. Conversely, PEEP that is too low can also lead to higher driving pressures, especially in patients at increased risk of lung collapse (*e.g.*, obese patients and those being submitted to laparoscopy surgery). Therefore, targeting PEEP levels that aim to minimize both collapse and overdistention seems reasonable and may benefit patients.

Concerning the analysis of postoperative atelectasis, our sample size calculation was based on a study in which high PEEP caused a 40% reduction in the area of atelectasis (−100 to +100 Hounsfield units) in a *single* 5-mm computed tomography slice of the lung.[2] In our study, we obtained *whole lung* computed tomography after extubation in 40 patients. The volumetric computed tomography allowed us to compute mass and volume of atelectasis in the whole lung,[3] as opposed to just the area in a single slice. We chose the range between −200 to +100 Hounsfield units *a priori* because it has better correlation with shunt fraction[4] than the classic window of −100 to +100 Hounsfield units. A sensitivity analysis using this classic window showed similar results of lower lung collapse in the titrated PEEP group (table 1).

Finally, we agree with Girard and Carrier that weaning patients in the operating room on pressure support ventilation with low fraction of inspired oxygen (F_{IO_2}) and high PEEP is not usual care. In our institution, anesthesiologists usually wean patients on spontaneous breathing, without PEEP and on high F_{IO_2}. In our study, however, we standardized practice to keep the same intraoperative PEEP and F_{IO_2} with the intention to mitigate atelectasis formation during the weaning period. This choice might have helped preserve the increased recruitment obtained during the intraoperative period in the titrated PEEP arm. Indeed, Kostic *et al.*,[5] who used continuous positive airway pressure and low F_{IO_2} during weaning, also found a lasting benefit—after extubation—of lung recruitment and higher PEEP expressed as higher expiratory lung volume. We are unsure whether the negative results of previous studies[6,7] could be explained by the weaning phase because the weaning method is not described in detail in these articles. Further studies are warranted to assess the role of the weaning method on postoperative atelectasis.

Competing Interests

The authors declare no competing interests.

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