

## One Hand, Two Hands, or No Hands for Maximizing Airway Maneuvers?

ADEQUATE mask ventilation is an important task for anesthesiologists to ensure patient safety during general anesthesia induction. Although two hands are necessary in some patients, particularly obese patients with obstructive sleep apnea (OSA),<sup>1,2</sup> anesthesiologists most frequently use only one hand for airway maintenance with bag-and-mask ventilation. In the late 1950s, Safar *et al.*<sup>3,4</sup> scientifically tested and validated for the first time the clinical usefulness of a two-handed jaw-thrust method for reversing pharyngeal obstruction and for mouth-to-mouth breathing. "When the patient is supine, extension of the head and support of the mandible are best accomplished as follows: the operator places himself at the head of the patient; he firmly grasps with both hands the ascending rami of the mandible just beneath the ear lobes and pulls forcefully upward (anteriorly); the chin must "lead," so that the lower teeth are in front of the upper teeth."<sup>4</sup> They found mouth-to-mouth breathing to be superior to mouth-to-nose breathing, emphasizing "mouth first, nose second." The two-handed jaw-thrust method principally includes the so-called triple airway maneuvers (mandibular advancement, head extension, and mouth opening). Insertion of an oropharyngeal airway alone did not consistently establish a patent upper airway. Notably, they recognized 50 yr ago that obesity was a risk factor for difficult upper airway maintenance. The use of two hands was originally recommended for the jaw-thrust maneuver. Why, then, do we use only one hand? Is it because we believe we do very well with one hand as experts of airway maintenance? Is it because we need to assess adequacy of ventilation and adjust it with the other hand on the bag?

In this issue of ANESTHESIOLOGY, Kuna *et al.*<sup>5</sup> demonstrated that the mandible can be advanced 16.8 mm on average and that this mandibular advancement reestablished the decreased pharyngeal airway size during propofol anesthesia compared with that during wakefulness. From a clinical point of view, the maximum mandibular advancement may not be necessary for adequate mask ventilation in these nonobese young adults without OSA. Results of this study, however, provide the physiologic basis for constructing a strategy for airway man-

agement of patients with difficult mask ventilation, in particular obese OSA patients in whom best airway maintenance maneuvers are to be performed from the beginning of anesthesia induction.

The pharyngeal airway is surrounded by soft tissues, including the tongue and soft palate, which are enclosed by craniofacial bony structures, including the maxilla, mandible, and cervical vertebrae. We recently reported that an anatomical imbalance between the upper airway soft tissue volume and craniofacial size is associated with development of OSA.<sup>6</sup> Although the anatomical imbalance is partially compensated for by contraction of pharyngeal airway dilating muscles during wakefulness, these neural compensatory mechanisms are significantly depressed or abolished during sleep and general anesthesia, resulting in complete pharyngeal airway closure in OSA patients. Mechanical interventions for improving the upper airway anatomical imbalance are, therefore, necessary for reversing the closed pharyngeal airway in OSA patients during anesthesia.<sup>7</sup> Mandibular advancement, head extension, and the sniffing position enlarge the craniofacial size, thereby improving the upper airway anatomical balance. A sitting, lateral, or reversed Trendelenburg position reduces the gravitational impact of the excessive soft tissue volume on pharyngeal airway lumen, also improving the anatomical balance. Variable interaction of these mechanical interventions with structural properties of the pharyngeal airway may result in variations of the final pharyngeal airway patency during anesthesia. Maximizing mechanical interventions is crucial for securing a patent pharyngeal airway, particularly in obese OSA patients.

Responses to mechanical interventions in obese persons seem to differ from those in nonobese persons. We previously reported that mandibular advancement increased the retropalatal cross-sectional area in nonobese but not in obese persons.<sup>8</sup> In contrast, the retroglottal airway never failed to respond to mandibular advancement in obese persons, indicating an advantage of positive-pressure ventilation through an oral airway during anesthesia induction as evidenced by Safar *et al.* (although a different opinion was recently proposed in this journal<sup>9</sup>). Notably, beneficial effects of the sniffing position on the retroglottal airway patency seem to be smaller in obese OSA patients than in nonobese OSA patients.<sup>10</sup> Most anesthesiologists are likely unaware that an increase in lung volume improves the anatomical balance in the pharyngeal airway, possibly due to increasing longitudinal traction forces on the upper airway soft tissue.<sup>11</sup> The beneficial effect of an increase in lung volume is greater at the retropalatal airway of obese OSA patients than nonobese OSA patients.

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In addition to proper head and body positioning, key mechanical interventions are, in my opinion, maximum mandibular advancement with mouth opening for effective mask-to-mouth ventilation, and application of positive end-expiratory pressure. The question is whether we can accomplish this mission by bag-and-mask ventilation in obese OSA patients. I strongly doubt that anesthesiologists are able to advance and maintain the mandible forward by 16.8 mm and open the mouth with only one hand holding the large jaw. It would also be technically difficult to adjust the valve position for achieving optimal ventilation by constant positive end-expiratory pressure. A delay in maintaining adequate ventilation would likely result in rapid development of severe hypoxemia in obese OSA patients. I therefore always use two hands for performing the triple airway maneuver during anesthesia induction. I advance the mandible forward with both hands at the ascending rami without touching the mandible body as proposed by Safar *et al.*<sup>4</sup> I do not recommend the “E-C clamp” mask holding technique to our anesthesia residents because it holds the mandible body, closes the mouth, and tends to push the submandibular region. I do not squeeze the bag, but use the anesthesia ventilator for ventilation. This two-handed mask ventilation can be easily performed without the help of another anesthesiologist. In addition to achievement of good airway patency without delay and throughout the anesthesia induction, there are several advantages of this technique over bag-and-mask ventilation: First, application of positive end-expiratory pressure prevents reduction of lung volume contributing to maintenance of oxygenation and pharyngeal airway patency; second, mask leak, which is another cause of difficult mask ventilation, can be more easily remedied by the use of two hands; and third, it minimizes gastric gas distention when pressure-controlled ventilation is applied. Inadequate airway patency is indicated by low tidal volume during pressure-controlled ventilation or high airway pressure during volume-controlled ventilation.

An oral or nasal airway may assist the airway maintenance maneuver; however, adequate anesthesia depth is

necessary for oral airway insertion, and nasal airway insertion often causes nasal bleeding. An oral mandibular advancement appliance used by Kuna *et al.*<sup>5</sup> may be comfortably attached before anesthesia induction and may make one-handed mask ventilation effective, thereby possibly freeing a hand during induction of general anesthesia in combination with a tightly fitted mask.

We still are indebted to the pioneering work performed in the 1950s regarding maneuvers to maintain a patent airway. Hard facts do not change over time. However, we need to confirm, develop, and modify perioperative airway management strategies in accordance with the progress of technology and procedures of anesthesiology and with our constant advancement in the understanding of upper airway physiology.

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