

Oxygenation, Not Intubation, Does Matter

DESPITE establishments of guidelines for difficult airway management in North American and European countries, unexpected difficulty of airway management during anesthesia induction is still a major cause of anesthesia-related death and hypoxic brain damage and a challenging task for anesthesiologists.^{1,2} In this issue of *ANESTHESIOLOGY*, two leading airway investigation groups provide us with remarkable results of their clinical studies of airway managements.³⁻⁶ Certainly, results of these studies may not be directly applicable to other institutes consisting of a different patient population and to groups or societies, including heterogeneous anesthesiologists and intubation operators. However, we should not lose this opportunity to carefully interpret and analyze the patient outcomes determined either prospectively^{3,5} or retrospectively^{4,6} for further improving already established guidelines and constructing a better new airway algorithm in other institutes or countries in the future.

Intubation Is Not as Difficult as It Was

Amathieu *et al.* report their experience of an airway management algorithm using a gum elastic bougie, Airtraq, and *LMA CTrach*TM.³ They prospectively tested their algorithm in 12,221 patients given general anesthesia for elective surgery, limiting abdominal, gynecologic, and thyroid surgeries, in a relatively small tertiary French hospital with five operating rooms. All anesthesia inductions were managed by well-educated and experienced nurse anesthetists and anesthesiologists strictly adhering to the algorithm. Although they encountered 125 patients with either difficult facemask ventilation (FMV) ($n = 104$) and failure of direct laryngoscopy, despite use of the gum elastic bougie ($n = 21$), all patients with difficult airways were successfully intubated by using either Airtraq or *LMA CTrach*TM.

Aziz *et al.*⁴ retrospectively evaluated usefulness and efficacy of the Glidescope (GVL; Verathon Medical, Bothell, WA) from 71,570 intubation records, including 2,004 GVL intubations in two academic medical centers in United States. They found a high success rate of GVL intubation in both primary airway management (98%; 1,712 of 1,755) and rescue-failed direct laryngoscopy (94%; 224 of 239). Use of a gum elastic bougie facilitated successful GVL intubation (2.5%) in agreement with results of the study by Amathieu *et al.*^{3,4} in which the bougie was combined with direct laryn-

goscopy (1.9%). Tracheal intubation (TI) after failed GVL attempts ($n = 60$) was most frequently achieved using direct laryngoscopy (47%) or flexible fiberoptic intubation (32%). Use of a supraglottic airway (SGA) (5%) or other techniques was less common.

Both studies clearly demonstrated usefulness of combined use of airway devices, SGA, and airway imaging for successful TI. This is also true in prehospital and in-hospital emergency TIs, as shown by Combes *et al.*⁵ and Martin *et al.*⁶ TI is less difficult than in the past, primarily as a result of the development of SGAs and airway imaging devices. Should we add a new TI device in the airway algorithm whenever usefulness of each device for improving TI success rate is evidenced? Optimal or preferred TI techniques and devices are different for each individual patient and depend on the operator. Furthermore, various new TI devices become available every year, making long-term standardization of the TI devices difficult for groups or societies, including heterogeneous anesthesiologists. Airway algorithm may no longer be successful for TI.

Oxygenation Is Our Goal in Airway Management

Given the achievements of our anesthesia societies for improving TI success rate, the question is whether successful TI is our final goal in airway management. Incidence of FMV difficulty was much greater than that of TI failure in the study of Amathieu *et al.*³ Hypoxemia ($SpO_2 < 90\%$) occurred even during the successful TI procedures (0.7% of all patients).³ More severe hypoxemia ($SpO_2 < 80\%$) episodes frequently occurred during failed TI procedures with either Macintosh or Airtraq laryngoscopes in morbidly obese patients with reduced apnea tolerance.³ Development of hypoxemia was more frequent in prehospital patients with difficult TI (26%).⁵ Needless to say, temporary hypoxemia may

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not influence patient outcomes. However, depending on the skill level of the operators and availability of alternative TI devices, some of these hypoxemic events could be prolonged, possibly leading to more severe hypoxemia and brain damage in other institutes. If hypoxemia during TI is avoidable by modifying and improving the airway management strategy, safety of airway management and outcomes of resuscitation would be significantly improved. Accordingly, maintenance of oxygenation or rapid recovery from hypoxemia, we believe, is our final goal of airway management during induction of anesthesia and resuscitation. It is time to change our concept of difficult airway and the fundamental strategy of safe airway management.

Role of Airway Algorithm

Failure of TI does not directly lead to adverse outcomes, such as death or brain injury as a result of oxygenation failure, as long as FMV is adequate. Furthermore, approximately one third of difficult FMV is accompanied by difficult or impossible TI.⁷ Accordingly, difficult or impossible FMV is a more critical condition to be avoided and resolved in anesthetized patients than TI failure. The difficult airway algorithm of the American Society of Anesthesiologists for patients during general anesthesia induction begins with unsuccessful initial TI attempts.² The algorithm aims to solve the TI problems and to prevent adverse outcomes. This strategy significantly differs from that of the airway algorithm used in the study by Amathieu *et al.* The investigators principally focus on predicted or encountered FMV difficulty for deciding intubation techniques. Succinylcholine was given for patients with grade III and IV FMV difficulty to reduce the duration of inadequate ventilation, and *LMA CTrach*TM was inserted as an initial airway device for patients with grade IV FMV difficulty (fig. 1). Although usefulness of their airway algorithm was validated by successful TI in all anesthetized patients without adverse outcomes, they were unable to prevent development of hypoxemia during TI attempts (0.8%).³ We have not yet succeeded in developing an airway algorithm for always maintaining oxygen-

	Initial Airway Device for TI	
	Amathieu's Strategy	SGA-first Strategy
Easy FMV (Grade 1, 2)	Laryngoscopy	Any TI device
Difficult FMV (Grade 3)		
Inadequate FMV (Grade 4)	SGA	SGA

Fig. 1. Two different strategies for determining an initial airway device for tracheal intubation (TI) based on difficulty of facemask ventilation (FMV). Incidence of hypoxemia during TI could be reduced by expanding indication of use of supraglottic airway (SGA). SGA-first strategy needs to be tested in the future prospective study. Laryngoscopy = direct or video-assisted laryngoscopy.

ation throughout each step of airway security in all anesthetized and unconscious patients.

Early Use of SGA for Maintaining or Recovering Oxygenation

To our knowledge, direct or video-assisted laryngoscopy is the initial intubation device in all airway algorithms published to date except in the Amathieu *et al.* algorithm. In general, cessation of ventilation is much longer during laryngoscopy, in particular when it is difficult, than during SGA insertion. Accordingly, expansion of SGA indications may be a key for minimizing interruption of oxygen supply and maintaining oxygenation as some of new SGA devices allow both ventilation and intubation (fig. 1). Initial use of the *LMA CTrach*TM for patients with grade III FMV difficulty and obesity could have prevented development of hypoxemia in the study by Amathieu *et al.* Previous or prophylactic use of SGAs and techniques proven to be effective for maintaining and improving FMV could prevent or reduce hypoxemic episodes during anesthesia induction.⁸ This strategy may be more important in prehospital and in-hospital emergent patients who are not preoxygenated and have high risk for developing severe hypoxemia during short apnea. In fact, SGA-first strategy appears to improve airway management by unskilled operators during anesthesia induction and outcomes of neonatal resuscitation.^{9,10}

In conclusion, we encourage anesthesiologists to explore techniques or devices for maintaining oxygenation throughout induction of anesthesia. Future prospective studies should be directed to test whether the oxygenation-oriented strategy further improves safety and quality of our airway management in anesthetized and critically ill patients.

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