In their review, El-Orbany and Woehlck¹ shed light on the problem of difficult mask ventilation (DMV). They raise concerns about definitions and highlight the pathophysiology, incidence, and prediction of this rather neglected aspect of airway management. Their review analyzes the relationship between DMV and difficult intubation and outlines corrective measures and management options.

We concur with the authors that clear and meaningful definitions are needed for DMV as well as other aspects of airway management. There is no consensus on an exact definition of the sniffing, neutral, and simple extension positions. In general, the sniffing position implies extension at the atlantooccipital joint and flexion at the cervical spine, but it is not clear how high from horizontal the head should be elevated for the sniffing position. Should the head elevation be greater in tall-necked than in short-necked subjects? Because no strict definitions exist, research papers cannot be interpreted or compared fairly.¹⁻³

In the algorithm proposed by El-Orbany and Woehlck¹ (and in the American Society of Anesthesiologists difficult airway algorithm), reference to 2-person mask ventilation is emphasized. Benumof⁴ defined the optimal attempt at mask ventilation as a 2-person method with appropriately sized oro- or nasopharyngeal airways. Unfortunately, when unanticipated DMV is encountered, a second anesthesiologist is not always available.⁵ Rather than relying on another colleague to compress the reservoir bag, the anesthesiologist can use both hands to obtain appropriate mask seal, while the ventilator can be used to deliver the desired tidal volume.⁵ The lone anesthesiologist then uses both hands to advance the mandible, and the head straps are used to further improve the mask seal. Neither the 1-person, 2-handed mask ventilation, nor the use of the ventilator to deliver tidal volume is new. In 1959, Safar et al.⁶ validated the usefulness of a 2-handed jaw thrust method for reversing pharyngeal obstruction. Ventilators have been utilized in studying the efficacy of mask ventilation in children⁷ and in the management of DMV in adults.⁸ Alternatives to the use of the ventilator include compressing the reservoir bag between the knees, under the axilla, or even under the foot,⁵ while using both hands to maintain an adequate airway. These maneuvers, however, require that the reservoir bag be connected to a long corrugated hose, instead of being mounted on the anesthesia machine.⁵

The upper airway can be obstructed by soft tissue at the pharyngeal or laryngeal level, and by laryngospasm induced by opioids and anesthetics, or occurring after tracheal extubation. In patients with obstructive sleep apnea (OSA), anatomical imbalance between the upper airway soft tissue volume and craniofacial size is partially corrected for by the contraction of the pharyngeal airway dilating muscles during wakefulness.⁹ When patients are unconscious, the neuromuscular control of the upper airway muscles becomes diminished or lost.⁹ The tongue and structures attached to the hyoid bone gravitate toward the posterior pharyngeal wall, causing various degrees of airway obstruction. Maximum mandibular advancement with mouth opening (with the use of oro- or nasopharyngeal airways) and assumption of the sniffing position can be effective in opening the airway⁸⁻¹⁰ by stretching the genioglossus muscle and pulling...

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the tongue away from the posterior pharyngeal wall. Head-up or reverse Trendelenburg position also reduces the gravitational impact of the excessive soft tissue on pharyngeal patency. When these maneuvers fail, occlusion of the glottis by supra-epiglottic cysts, base of the tongue tumors, or hypertrophy of lingual tonsils should be suspected.

Understanding the mechanics of laryngospasm is crucial to proper treatment. Fink described 2 types of laryngeal closure: the glottic shutter, controlled by the intrinsic laryngeal muscles, and the ball-valve closure, controlled by the extrinsic and intrinsic laryngeal muscles. The glottic shutter is caused by approximation of the vocal cords because of the loss of the tone of the abductor muscles. Glottic constriction is analogous to constriction of a Venturi tube. Because the velocity is greatest where the passage is narrowest, airway pressure is lowest at the subglottic area and becomes less than atmospheric during inspiration (Bernoulli effect). During spontaneous inspiratory efforts, passage of gases through the glottis generates a force that tends to draw the vocal cords together. Normally, this force is opposed by the tone of the abductor muscles. During anesthesia, the tone is lost and the Bernoulli effect becomes pronounced, resulting in inspiratory stridor. Positive airway pressure neutralizes the Bernoulli effect and abolishes the stridor.

In the ball-valve closure, the vocal cords are adducted, swiftly followed by adduction of the false cords. In addition, the extrinsic laryngeal muscles come into play, shortening the thyrohyoid distance and completely closing the larynx. Applying positive airway pressure may worsen ball-valve closure. Inflation of the pharynx distends the piriform fossae, pressing the aryepiglottic folds more firmly against the base of the tongue away from the posterior pharyngeal wall. The extrinsic laryngeal muscles, and the ball-valve closure, controlled by the extrinsic and intrinsic laryngeal muscles. The glottic shutter is caused by approximation of the vocal cords because of the loss of the tone of the abductor muscles. Glottic constriction is analogous to constriction of a Venturi tube. Because the velocity is greatest where the passage is narrowest, airway pressure is lowest at the subglottic area and becomes less than atmospheric during inspiration (Bernoulli effect). During spontaneous inspiratory efforts, passage of gases through the glottis generates a force that tends to draw the vocal cords together. Normally, this force is opposed by the tone of the abductor muscles. During anesthesia, the tone is lost and the Bernoulli effect becomes pronounced, resulting in inspiratory stridor. Positive airway pressure neutralizes the Bernoulli effect and abolishes the stridor.

The corrective measures outlined in the review apply only to common causes of upper airway obstruction. The reader is referred to other sources for the management of lower airway obstruction. Obviously, the safest approach is to plan for awake fiberoptic intubation in patients with expected difficult or impossible facemask ventilation. Other interim measures in the management of expected or unexpected DMV clearly depend on etiology. Maximal mandibular advancement can be effective for pharyngeal soft tissue obstruction (OSA/obesity) or laryngeal obstruction by ball-valve closure. Muscle relaxation can be a lifesaving measure in severe ball-valve closure or opioid-induced vocal cord spasm. Supraglottic devices can be effective in overcoming pharyngeal soft tissue obstruction but are not effective in the treatment of laryngospasm or lower airway obstruction.

It is entrenched in the mind of many anesthesiologists that lung ventilation must be established after induction of anesthesia and before administration of a neuromuscular blocking drug (NMBD); the exception is the patient undergoing rapid sequence induction. However, in a survey assessing this practice, 30% of the respondents always checked mask ventilation before the administration of an NMBD, 39% never checked, and 31% did so in the case of a known or anticipated difficulty with the airway. The basis for such a practice is that if mask ventilation becomes impossible after induction, unparalyzed patients can be awakened for application of an alternative technique, typically awake fiberoptic-aided intubation. However, this practice is not supported by evidence. First, even if an NMBD is withheld, awakening patients with obstructed airways may not be feasible, and urgent restoration of the airway becomes necessary before hypoxemia supervenes. Second, studies do not show that awakening the patient under these circumstances is what happens in real-life situations. In a report of 22,660 facemask ventilation attempts, DMV and impossible mask ventilation occurred in 313 (1.4%) and 37 (0.16%), respectively, but no patient was awakened. Furthermore, all 37 patients with impossible mask ventilation had been given an NMBD to aid tracheal intubation. Third, a suspicion that a patient with a questionable airway may need to be awakened for tracheal intubation may lead to underdosing of induction drugs, which could itself result in DMV. Lastly, there is convincing evidence that an NMBD makes intubation easier, although 1 study showed that neuromuscular blockade does not affect the efficiency of mask ventilation in patients with normal airways. In patients whose lungs are difficult to ventilate via a facemask, ventilation becomes easier with neuromuscular blockade, which may be attributed to the onset of muscle relaxation. Reluctance to give an NMBD in these situations is more likely to result in DMV, compounding the difficulties that arise from a low-dose induction drug.

Anesthesiologists have a variety of airway management devices from which to choose. The use of the laryngeal mask airway and other extraglottic devices should be encouraged when facemask ventilation is difficult. The laryngeal mask airway can be used as a substitute airway, as an aid to tracheal intubation, and as a bridge for smooth extubation of patients with a difficult airway. Two devices, 1 old and 1 new, may function to improve DMV. The binasopharyngeal airway system incorporates 2 nasopharyngeal airways attached to an adapter, which can be connected to the Y-piece of the breathing circuit. The lubricated airways are introduced through each nostril, and the
It is imperative that anesthesiologists master the science and art of mask ventilation. Even simple maneuvers, such as maximizing oxygenation before anesthetic induction, 1-person, 2-handed mask ventilation, prevention of gastric inflation during mask ventilation, and packing the inside of the mouth with gauze to achieve a tight-fitting mask in edentulous patients should be practiced to perfection. Familiarity with various devices including the binasopharyngeal airway system and appliances used to maximize mandibular advancement is highly desirable. Future research should be directed toward the development of algorithms for the management of specific situations and identifying conditions in which preservation of spontaneous ventilation or establishing lung ventilation before the administration of an NMBD is beneficial. Finally, clear meaningful definitions and nomenclature must be developed for all aspects of airway management.

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Figure 1. The intraoral appliance (EMA-T) used to advance the mandible. It consists of plastic trays for the upper and lower dental arches. When the appliance is in place, the mandible has recently become available (Fig. 1). Such a system can be used early during induction and also after tracheal extubation to overcome naso- and oropharyngeal obstructions. An intraoral appliance that is used to advance the mandible has recently become available (Fig. 1). Such appliances may become useful in maintaining pharyngeal patency in anesthetized patients with OSA.