

Shall we stop midway: Between the face mask and supraglottic airway

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Commentary

Face mask ventilation is the cornerstone of basic airway management but is not easy to master [1]. Ventilation of a patient using a face mask may be required when there is inadequate ventilation, either due to inadequate respiratory effort or due to airway obstruction. The conventional face mask is the oldest airway management device in use since 1847, when it was introduced by the British physician John Snow to administer inhalational anesthesia. Although it seems deceptively simple to use, the conventional face mask is often challenging to use successfully even after extensive training and experience [2,3]. Bag mask ventilation is usually a prelude to definitive airway management with endotracheal intubation and its success requires a patent airway, a good mask seal, and proper ventilation using adequate tidal volumes and respiratory rate. If face mask ventilation is unsuccessful i.e. there is an obstruction to air flow and /or the chest does not rise, the clinician needs to consider the most likely causes.

The patency of the airway should be maintained using airway opening maneuvers. Soft tissue airway obstruction occurs in the unconscious patient due to tongue fall into the posterior pharynx and a loss of muscle tone in the soft palate [4,5]. In addition, in the trauma victim, airway obstruction may be compounded by the presence of foreign bodies, blood, secretions or injured tissues. Oral suctioning and simple airway maneuvers, such as head-tilt, chin-lift or jaw-thrust with or without a head tilt, are required to “open” the airway. Adjuncts like oropharyngeal and nasopharyngeal airways may also be used. To achieve a good mask seal, the correct size mask should be correctly positioned on the patient’s face and an optimum seal achieved. Various techniques of mask holding have been described, and mask ventilation may be performed using one or two hands, but, whenever possible, a two-handed technique is preferred. Once airway patency and an adequate seal are achieved, minute ventilation should be delivered with an optimum tidal volume and rate of breathing.

Patient-related factors affecting the success of face mask ventilation include age, obesity, presence of facial hair and piercings, dentition, anatomical variations, ability to protrude the jaw, facial masses, and facial trauma. Inadequate mask seal is likely in bearded and edentulous patients and older patients with sunken cheeks [6,7]. Other causes resulting in inadequate ventilation include improper mask size, inadequate airway opening maneuvers, and lack of use of an appropriate airway adjunct. Operator dependent factors include hand size, grip strength, gender, physical conditioning, experience, training, distraction, and stress-coping skills [8,9].

Certain acronyms have been devised to predict patients who are likely to be difficult to ventilate with a face mask [10-13]. “ROMAN” [14] has been suggested in which R is for Radiation (head and neck)/Restriction (poor lung compliance), O is for Obesity/Obstruction (upper airway)/Obstructive sleep apnea, M for Mask seal/Mallampati (class III or IV)/ Male, A for Age over 55 years and N

for No teeth. Other mnemonics suggested are “MMMMASK” [15] where M is Male gender, M is Mask seal (affected by beard or being edentulous), M is Mallampati grade 3 or 4 and M is Mandibular protrusion, A is Age, S is Snoring and obstructive sleep apnea and K is Kilograms (weight) and “OBESE” [10] where O is Obese (BMI>26 kg/m²), B is Bearded, E is Edentulous, S is Snoring and E is for Elderly (>55 years).

The efficiency of face mask ventilation can be measured both subjectively and objectively. Subjective markers indicating adequate ventilation are cyclical condensation on the dome of the face mask chest expansion, auscultation of bilateral respiratory sounds and low resistance to manual inspiration along with rapid lung deflation during expiration. There should be an absence of gastric insufflation of ventilation gases as indicated by epigastric sounds and abdominal distention. Objective markers may be considered to be a normal oxygen saturation and capnography waveform with acceptable airway pressures and delivery of satisfactory tidal volumes. Low tidal volumes in an adult patient (3-5 ml/kg) or dead space ventilation (<150 ml) with high airway pressures (30–35 cm H₂O) represents a poor outcome and an “inadequate” ventilation attempt despite condensation on the mask and a marginal ETCO₂ tracing [16].

Difficult FMV may result in many complications, the most serious being a failure to oxygenate the patient leading to hypoxic brain injury, myocardial ischemia or even death. Patients may develop pressure injury to the eyes, nose, and mouth due to excessive use of force with the mask. Eye injuries can also be due to dry gases leaking from the mask. If there is any airway obstruction, air is directed into the stomach increasing intra-gastric pressure which will elevate the diaphragm, decrease lung compliance, and further increase the difficulty of mask ventilation and predispose the patient to aspiration of gastric contents.

Another major issue with the use of face masks was that the mask had to be held on the face at all times by the anesthetist thus restricting the use of their hands for other activities. Although a variety of harnesses have been described to seal the mask against the patient's face, it is often difficult to prevent the jaw from falling back. Hence, face mask ventilation is not a ‘hands-free’ technique in most patients. Airway management under anesthesia was earlier limited to either endotracheal intubation or a facemask with an oral or nasopharyngeal airway. Use of face mask ventilation was difficult during prolonged procedures in which use of endotracheal intubation was not deemed necessary. There was a need for a device to form a bridge between the conventional face mask and an endotracheal tube.

It was in 1981 that Dr Archie Brain began to study the anatomy and physiology of the upper airway in great detail. Dr Brain was providing dental anesthesia at the time and it was usual practice to administer volatile anesthetic through a Goldman dental nasal mask attached to a Magill breathing system. The Goldman mask had a detachable rubber cuff that formed an ellipse and a flange for attachment to the rigid component of the mask. Dr Brain found a similarity in the general size and shape of the cuff of the Goldman dental nasal mask and the space in the pharynx and reasoned that the respiratory tract is like a tube terminating at the glottis, and it should be logical to place another tube ending in a mask directly over the glottic inlet [17]. This was what finally resulted in the genesis of the laryngeal mask airway family. The anesthesia community quickly realized the potential benefits of the laryngeal mask airway.

A supraglottic device made it easy to obtain an unobstructed hands-free airway within a few seconds without additional equipment and soon there was sufficient evidence to suggest that the emergence characteristics were far smoother than that of a tracheal tube.

However, any airway device that comes into contact with airway structures has the potential to cause injury and complication. Pharyngeal morbidity related to the use of supraglottic airways includes sore throat, dysphonia, and dysphagia [18,19]. Other rare injuries reported are arytenoid dislocation and pharyngeal rupture with subsequent pneumomediastinum or mediastinitis [20]. With incorrect and prolonged use, there may be neurovascular compression [18,21,22]. Also, their use requires an obtundation of airway reflexes as occurs in the unconscious or anesthetized patient.

Keeping in mind that an important cause of inadequate or impossible face mask ventilation is a failure to make an adequate seal which may be due to the presence of facial hair, sunken cheeks, piercings on lips and face, lack of teeth, presence of blood or mucus or facial structural deformities, a novel intraoral mask has been developed which is called NuMask® (NuMask, Inc., Woodland Hills, CA, USA). This has been developed to eliminate the difficulties related to anatomical facial features by creating a seal inside the mouth of the patient [23,24]. The dead space is also lower in this intraoral mask as compared to the conventional face masks. One size is recommended for use in all adult patients, which is another advantage of this device over the conventional ones. While a conventional face mask needs to be firmly pressed onto the face of the patient and can cause trauma to the eyes, bridge of the nose, chin, and cheeks, the intraoral mask, as the name suggests, is placed inside the mouth between the lips and teeth of the patients [15]. It does not need to be pressed very hard in order to make a seal and may be easier to hold in place as the operator's fingers do not need to be sprayed. Although the risks of trauma are less likely, it may cause trauma to lips, teeth, or the labial frenulum if held improperly. The intraoral mask is held using the modified CE grip. After placing the flaps of the Numask between the lips and teeth, the operator's index finger is wrapped around the lower lip of the patient and the patient's nose is placed in the first web space. The hand is then closed, pulling the lips and nose towards the stem of the mask, occluding the nose and the remaining fingers are used to elevate the jaw, providing jaw thrust. It is required to be held with only one hand and should be easier for operators with smaller hands and may also result in less hand fatigue.

The literature has reported various innovations in the use of a conventional face mask to facilitate face mask ventilation in patients who are anticipated to be difficult to mask ventilate. Langeron *et al.* [10] suggested that dentures may be left in situ during induction of anesthesia in order to maintain facial support in edentulous patients. Crooke *et al.* placed the caudal end of the mask between the inferior lip and the alveolar ridge [25]. In a study by Racin *et al.*, [26], the caudal end of the mask was moved to above the lower lip while maintaining the head in extension while the cephalad end of the mask remained in the same location. This lower lip face mask placement reduced the air leak by 95% in edentulous patients. Yazicioğlu *et al.* [27] placed a pediatric sized facemask only over the mouth with the mask rotated with its inferior end placed toward the nose and held using a 1-handed EC-clamp technique. This decreased the incidence of difficult mask ventilation and the gas leak around the mask and provided delivery of a higher tidal

volume as compared with a conventional face mask. There are only a few studies using Numask. Cadaver studies have suggested that it is superior to the conventional face mask for providing ventilation [9,24,28]. However, we cannot directly extrapolate the results of cadaver studies to humans. Various factors such as skin elasticity, chest wall and lung compliance, jaw tone, muscle tone, and so on are different in living and cadaveric subjects and play a significant role during ventilation. Also mask ventilation in the case of cadavers does not pose as much challenge and stress as occur in clinical situations.

Nimmagadda *et al.* [23] used NuMask IOM for pre-oxygenation and found it be as effective as the conventional face mask in achieving maximal pre-oxygenation during tidal volume breathing, hence suggesting that it provides an equivalent seal. Nance *et al.* [29] compared ventilation using the NuMask® with a traditional mask in 28 anaesthetized and paralyzed patients, with characteristics associated with difficult mask ventilation and concluded that the NuMask® was associated with greater measured exhaled tidal volumes and smaller air leaks and appeared to be an effective tool for mask ventilating patients with traditional predictors of difficult mask ventilation. Alkan *et al.* [30] reported that ventilation success was greater with the intraoral mask as compared to the classic face mask in terms of successful ventilation and lower air leaks with greater tidal volumes. The anxiety ratings of practitioners were similar with the use both masks while the work-load rating was higher with the intraoral mask. In a more recent study, Gaur *et al.* [31] found no difference in the expired minute volumes when using an intraoral mask and a classic face mask in anesthetized and paralyzed patients without any risk factors for difficult mask ventilation. Although further studies are required in patients with predicted difficult face mask ventilation, this novel device may prove useful in the emergency department and operation theatres to facilitate successful ventilation in patients where there is difficult in forming a facial seal with the conventional face mask. It may thus have a role parallel to that of a conventional face mask i.e. before the insertion of a supraglottic device or an endotracheal tube. Although there is a wide array of airway equipment already available for use in different scenarios, this may prove to be a valuable adjunct to the vast armamentarium of airway devices already available.

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