Prospective view for mask design

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Face mask, nasal, and oral airway devices are used to secure the airway of patients in critical condition during resuscitation (1). However, without their proper operation, these devices potentially cause injury (1-4). In this article, we focus on the evolution of the face mask, and probe into the next move to improve airway management.

Evolution of the face mask

Face masks establish an air-seal around the sides of nose and mouth to connect the skin of face and bag ventilation support system. An ideal face mask should seal the skin tightly, create minimal pressure, and be least likely to increase the volume of the dead space. To achieve these goals, several types of face mask have been developed, and different airway management techniques have evolved.

Basically, a face mask consists of the body (cup), the seal (rim), a connector, and/or a strap hook. The anatomic mask (Connell mask) was the original design used to fit and create a seal over the mouth and nose. A fixed triangular or pyramidal shape might be difficult to fit on the faces of some patients, particularly those with features that deviate from the classic Caucasian features. The latex material used for the seal may cause allergy. Repeated use and cleaning results in the decay of the face mask.

The Patil-Syracuse mask is a variation of the Connell mask. In addition to the plastic material with inflated cushion rim, it has a sealed nipple or stretchable disc that allows fiberoptic airway intervention and intubation. The clear plastic allows the user to observe conditions inside the mask, is cost-effective, and enabled the creation of disposable face masks.

To reduce the dead space, the Rendell-Baker-Soucek mask was designed with a small triangular cup and no inflated cushion. It was originally designed for pediatric patients, who have more pliable facial soft tissue that allows for an effective seal.

The air-mask-bag unit mask is made of transparent plastic. With an inflatable cuff, it provides an adjustable mechanism for seal with bag ventilation, and is suitable for patients of all ages in emergencies.

Current challenges in face mask ventilation

The advancements in face mask ventilation have improved airway management; however, challenges still exist in this regard. Incidences of difficult mask ventilation (DMV) are estimated to be 0.08–13.00% and 45.9% in operating rooms and emergency departments, respectively (5-9). DMV potentially leads to severe cardiovascular collapse, cardiac arrest, hypoxic brain damage, and death (2,10). DMV also increases the risk of airway trauma, nerve injury, gastric insufflation, aspiration, vomiting, over-inflation (inflation pressures >20 cmH_2O), eye and eyelid injury, and nasal bleeding/false passage by dissecting nasal tissues (with nasopharyngeal airways) during the procedure, if the operator is not attentive to the anatomical structures under the mask (1-4). Therefore, the incidence of DMV is unacceptably high (5-9). Further improvement of mask designs is required.

Anatomical variations are the major cause for DMV. Predictors of DMV in the literature include having a beard (6,11), sunken cheeks (9), a double chin (9), lack of teeth (9,11-13), history of snoring or obstructive sleep apnea (6,11,12), limited jaw protrusion (11), a thick short neck (9), a history of neck radiation (6-8,11,12,14), a higher body mass index or weight (11,12), older age (11,12), male sex (6,12), decreased thyromental distance, and a high modified Mallampati score (3 or 4) (6,11,12). Most of the predictors of difficult airways are based on anatomical variation (6,15-18). As the number of predictors of difficulty increases, the probability of actually encountering problems increases (17-19). Hence, development of skill or devices for mask ventilation to overcome the anatomical variations is a potential resolution for DMV.

Current resolutions for difficult face mask ventilation

Airway management maneuvers and techniques

Based on the anatomic relationships, head tilt, chin lift, jaw thrust, and proper head/shoulder position to keep neck slightly extension are four simple, applicable maneuvers to improve the patency of the airway. Two-handed two-person mask ventilation, which is believed to create a more effective seal, is an alternative when encountering DMV using one-person mask ventilation. However, an increase in the pressure used to seal the face mask could cause injury to the facial skin (1,20).

Face mask adjuncts

Securing straps help keep face masks in place, and chin retainer bars support the chin from below and gently extend the head and neck. These devices create pressure to seal the face mask, maintain the airway, and also free the hands of clinicians to attend other tasks. Furthermore, seal accessory attachments are available for certain types of face masks to seal the leak between the mask and skin.

Laryngeal mask airway and cuffed oropharyngeal airway

The laryngeal mask and cuffed oropharyngeal airway are supraglottic airway devices, of intermediate intensity and invasiveness between the face mask and the endotracheal tube, and is an alternative if the facial contours of the patient are not suited for the standard face mask (21-24). On the other hand, laryngeal intubation with cuff inflation could cause malpositioning, upper airway obstruction, and an increase in airway resistance, which potentially leads to aspiration, ischemia of the pharyngeal mucosa, tongue cyanosis, bronchoconstriction, upper airway obstruction-related pulmonary edema, and inadequate ventilation (22).

Nasal mask ventilation

Nasal mask ventilation is able to create a pressure gradient between the nasopharyngeal and oropharyngeal cavities, and enhances ventilation during breathing (25,26). With limited available evidence, it may be an option in DMV, especially for those with anatomical variations that increase airway resistance (23,27).

Conclusions

The design of the face mask has been much upgraded; however, DMV still threatens the lives of patients. There are many alternative rescue methods available to establish the airway, but we are not satisfied with because of the potential complications of these methods. Future studies focusing on mask design to overcome these problems are valuable.

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Footnote

Conflicts of Interests: The authors have no conflicts of interest to declare.

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