



Special article

The adult ergonomic face mask concept: historical and theoretical perspectives

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Abstract The fundamental skill required of the anesthesiologist and rescuer is to treat upper airway obstruction and maintain adequate ventilation. Adult one-hand face mask ventilation is a complex technique, often applied with suboptimal results. The adult face mask in use today was not designed for one-handed ventilation but inherited its features from the 19th century face piece. The airway maneuver used with one-handed ventilation is not standardized. An ergonomic face mask has an asymmetrical dome that accommodates the hand grip required for chin lift and may be better for one-hand ventilation. The historical and theoretical considerations patent to the design and technique of the ergonomic face mask are reviewed.

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1. Introduction

Airway management is one of the most important skills in anesthesiology and emergency medicine practice. In the hospital and prehospital environment, face mask ventilation is a technique readily available in elective and emergent cases for spontaneous and positive pressure ventilation (PPV). Face mask ventilation is technically demanding and often misused, with suboptimal results [1].

The new ergonomic face mask (ErgoMask, King Systems, Noblesville, IN) is designed according to functional and

ergonomic principles. This article reviews the historical and theoretical considerations of the ErgoMask.

2. The face mask and the airway maneuvers: historical perspectives

The face mask is the oldest airway device in use in modern anesthesia and resuscitation and was the primary airway device for the first 100 years of general anesthesia with a single inhalational agent and spontaneously breathing patient. In the 1950s and 1960s the ventilation paradigm changed: PPV became routine and the endotracheal tube (ETT), the core airway device. More recently, the extensive use of the Laryngeal Mask Airway (LMA; Brain, 1988; Orthofix Intavent, Ltd., Maidenhead, UK) and other supraglottic airway devices accelerated the steady decline in face mask use. Nevertheless, adequate face mask ventilation is an essential component of the ASA Difficult

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Airway Algorithm [2] and the prehospital airway management algorithm [3].

John Snow introduced the “face piece” in anesthesia practice in 1847: “The face-piece, to include both the mouth and nostrils...is one of the greatest mechanical aids to the process of inhalation which has been contrived in modern times” [4]. The face piece had a central dome with left-right symmetry following the face symmetry and an anatomically shaped rim covered with silk to allow “greater adaptation to faces of different dimensions” (Fig. 1). Snow acknowledged Dr. Francis Sibson as the inventor [4]. Ralph Waters considered that “In 1847 John Snow copied the mask designed at the request of Humphry Davy by James Watt. Throughout the years each generation of anesthetist has copied the Watt mask” [5]. Regardless of its source – François Chaussier used a symmetrical face mask for resuscitation in 1780 [6] – the original face mask concept has been maintained to this day.

The adult face mask design focused on reducing dead space [7] and improving the seal between the face and the mask [8]. The modern disposable (transparent) face mask is considered to offer greater patient safety with prompt recognition of regurgitation and a better seal due to high-volume and low-pressure cuffs [9]. Face mask indications and complications were recently reviewed [10,11].

John Thomas Clover (1868) [12], Jacob Heiberg (1874) [13], and Friedrich von Esmarch (1877) [14] all recommended “the forward displacement of the mandible” to relieve upper airway obstruction in the anesthetized, spontaneously breathing patient. Clover’s clinical advice “to raise the chin from the sternum to give effect to the muscles between the chin and hyoid bone” [15] proved accurate in the apneic patient [16].

Landmark studies from the 1950s and 1960s by Elam et al. [17], Safar et al. [18], and Ruben et al. [19] validated

forward displacement of the mandible (ie, chin lift with head tilt and jaw thrust) as the most efficient technique to open the airway for artificial respiration with exhaled air (mouth to mouth, mouth to nose, and mouth to mask). These airway maneuvers involve two hands and are recommended by the International Committee on Resuscitation [20]. Upper airway obstruction in the unconscious patient is variable; it may occur at the epiglottis, oropharynx, and/or soft palate [10,21]. Regardless of the obstruction site, treatment is the same: forward displacement of the mandible and straightening of the mentum-geniohyoid-hyoid-thyroid line [10]. The benefits of stretching the anterior neck structures—and, subsequently, the pharynx—are numerous: increase of the laryngopharyngeal, oropharyngeal, and velopharyngeal caliber, anterior displacement of the epiglottis and hyoid, and improvement of airflow dynamics [22-24]. The clinical measure of an effective airway maneuver attempt is the “opening” of the sternomental distance.

The adult face mask in use today was not designed for the one-handed positive pressure face mask ventilation technique but inherited its features from the 19th century face piece. The airway maneuver applied with the generic one-hand face mask ventilation was not standardized. There is large variation in both performance and satisfaction between practitioners with the one-handed face mask ventilation with different face mask designs [25,26]. A functional disconnect exists between the (symmetric/historic) face mask design and the (asymmetric/modern) one-handed face mask ventilation technique.

2.1. The 'generic' one-hand face mask ventilation technique in adults

The two-handed face mask ventilation technique is considered more effective and safer than the one-handed technique because it generates an improved seal (symmetric pressures on the dome) and a correct airway maneuver (bilateral jaw thrust) [27]. Nevertheless, the single-person, one-handed technique is used frequently in anesthesiology and prehospital practice. One-handed face mask ventilation is a complex technique and requires considerable skill: the left hand lifts the chin and maintains the head extension while generating the mask seal [28]. The right hand establishes the ventilation parameters (tidal volume, inflation time). Coordination of these tasks determines the upper airway pressure (peak inspiratory pressure).

The adult left hand generic grip is shown in most textbooks with the fifth finger at the left mandibular angle [29,30]. This hand position neither generates nor maintains a jaw thrust [10], nor directs the middle and ring fingers to an optimal position for a chin lift, potentially compromising the ability to optimize the airway maneuver. Support of the angle of the mandible by one hand was insufficient for the maintenance of a patent airway [31]. The strap holder, when present, limits the thumb and the index finger to reach to the right side of the mask, potentially



Fig. 1 The Snow face piece, 1847 (replica; courtesy of the Wood Library - Museum of Anesthesiology, Park Ridge, IL).

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