Role of Capnography on Laryngeal Mask Airway Positioning: Preliminary Experience

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Abstract

Laryngeal mask airway (LMA) has been shown to be an alterative method of definite airway in first aid. However, the adequate methods to confirm LMA positioning remain to be elucidated. We reported our preliminary experiences of 5 cases with trauma who underwent awake application of LMA. Of them, three cases couldn't be confirmed the positioning of LMA by physical examination. Capnogaphy demonstrated two of the patients have initial improper positioning of the LMA. Under the guidance of end-tidal CO_2 readings, these two cases could be finally well positioned the LMA. In summary, our preliminary experience demonstrated that capnography should be routinely used as the confirmatory method of LMA positioning. *(Ann Disaster Med. 2003;2:7-13)*

Key words: Laryngeal Mask Airway; Capnography; First Aid; Emergency Medicine

Introduction

Since the first infra-red CO_2 measuring and recording apparatus was introduced in 1943 by Luft, capnography has evolved into an essential component of standard anesthesia monitoring armamentarium. The primary goal of anesthesiologists is to prevent hypoxia, and capnography helps to identify situations that can lead to hypoxia if uncorrected. Moreover, it also helps in the swift differential diagnosis of hypoxia before hypoxia can lead to irreversible brain damage. Because of these advantages, the utility of capnography has been extended outside of the operating room arena, in recent times, to emergency rooms, endoscopic suites, X-ray rooms and even on-site at emergency and trauma fields. Secondary confirmation of endotracheal tubing has been developed as one of the most important applications of capnogaphy.[1-3]

The laryngeal mask airway (LMA) has been well developed and has gained wide-spread popularity in clinical use in recent 10 years.[4,5] It allows either spontaneous or positive-pressure ventilation. With advances in the design, it has also received more attention as a tool for management of the difficult airway.[6-8] Because the placement of this device is less technique-dependent, the learning curve will be adequate.[9-13] In other words, the LMA has theoretical basis for the rescue team to learn and use under difficult situations.[13-17] However,

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there was still lacking in guidelines concerning confirming the adequacy of LMA positioning. We therein report our preliminary experiences of five cases that underwent LMA with secondary confirmation by capnography.

Methods

Study population and protocol

Five patients who consulting our institute due to multiple trauma and airway compromise were enrolled in this study. The protocol has been reviewed by our institute review board and informed consent was obtained. After detailed evaluation, emergency physicians decided to use LMA as the initial conduit for securing airway in the above five cases for whom awake intubation were determined.

After maintaining cervical immobilization, the patients were well pre-oxygenated. Under Sellick's maneuver, the physicians applied carefully the LMA and then confirm tube placement immediately, assessing the first breath delivered by the bag-mask unit. As the bag is squeezed, listen over the epigastrium and observe the chest wall for movement. The moisture condensation on the inside of the connecting tube with exhalation was also observed. Secondary confirmation was determined by a pulse oximetry, a continuous capnography and chest radiographs.

Capnography

The capnography we used was a commercialized product, Capnogard, from NovaMatrix Medical System Inc. (USA). It possessed a solid state mainstream sensor using single beam, non-dispersive infrared absorption, ratiometric measurement. Capnogram could be obtained within 15 sec., and full specifications within 60 sec. It could be applied to any adult and pediatric airway size, including LMA tubing. The accuracy was ±2 mmHg for 0-40 mmHg, ±5% of reading for 41-70 mmHg, ±8% of reading for 71-100 mmHg.

When used with the standard technique of listening to breath sounds, CO_2 monitoring is probably the best way to detect esophageal intubation. Although CO_2 may be present in the stomach it is rapidly flushed out during ventilation of the stomach and the end tidal CO_2 reading would decrease, resulting in a flat capnogram. Recently, the end tidal CO_2 detectors, which change color on exposure to 4% CO_2, have been used successfully to confirm tracheal intubation. These detectors can be used where CO_2 monitors are not available. It should be noted that in the presence of carbonated beverages in the stomach a $PETCO_2$ as high as 38 mmHg can be observed with esophageal ventilation and it may take at least six breaths for the end tidal CO_2 to decrease to zero. However, the CO_2 waveforms produced as a result are abnormal in shape and, therefore, could be detected earlier by capnography than capnometry.

Results

Table 1 depicts the clinical characteristics of five patients enrolled in this survey. Of them, three cases (case 2, case 3, and case 5) couldn't be confirmed the positioning of LMA by primary method (or physical examination). The uncertainty was due to audible breathing sound and epigastric bubbling. Continuous end-tidal CO_2 readings provided by near infra-red capnography revealed that two of the three cases (case 2 and case 3) did not have proper

Table 1. Clinical characteristics

Case Number	Age	Sex	Associated Injury	End-tidal CO_2(mmHg) (initial \ final)	Oxygen Saturation (%) (initial \ final)	SBP (mmHg) (initial \ final)	Pulse Rate (bpm) (initial \ final)
1	22	M	Head injury	34 \ 34	90 \ 96	148 \ 140	56 \ 60
2	43	M	C-spine injury	12 \ 30	93 \ 95	132 \ 128	104 \ 98
3	18	F	Facial injury	8 \ 29	92 \ 92	108 \ 112	118 \ 112
4	41	F	Head injury	30 \ 31	93 \ 93	150 \ 144	78 \ 80
5	36	M	Hemothorax	32 \ 33	92 \ 95	114 \ 110	123 \ 110

C-spine: cervical spine; SBP: systolic blood pressure

positioning of the LMA. Under guidance of the end-tidal CO_2 readings, the LMA was adjusted to a most adequate position. Chest radiographs demonstrated proper positioning of the LMA in all of these five cases.

Of the two cases with initial improper LMA positioning, the initial end-tidal CO_2 reading was 12 mmHg and 8 mmHg, respectively. Pulse oximetry demonstrated 93% and 92%. After repositioning, the end-tidal CO_2 readings increased to 30 mmHg and 29 mmHg, whereas oxygen saturation was 95% and 92%. Concomitant hemodynamic measurements were also depicted in Table 1. There were no definite hemodynamic changes for these five cases during the procedure.

Discussion

It has been well established the LMA and the Combitube dual-lumen tube are both time-saving procedure for maintaining patent airways in emergency situations.[12,13,18-20] However, in one study comparing the LMA and the Combitube for inexperienced operators, the rate of successful LMA placements in anesthesized and paralyzed patients was 100%, but the success rate only 92% with a Combitube.[13] More complicated procedures may contribute to the failure of the Combitube. In addition, the Combitube cannot be used in patients with a protective reflex or in pediatric victims, whereas the LMA has no such limitations.[21] In our previous study,[22] the rescue team and DMAT learned application of LMA easily and successfully. Evidence from some preliminary studies revealed that the application of the LMA is not affected by the patient position,[23] past experience,[10-12] consciousness level,[4-7] or cervical immobilization.[24-26] These characteristics make the LMA more attractive in rescue of victims in first aid.

The most important issue in intubating the patients is to confirm proper positioning of the tubing in the airway. A variety of electronic and mechanical devices are available for use both in-hospital ad outside the hospital. These devices range from simple and inexpensive to complex and costly and include several models of end-tidal CO_2 detectors and several types of esophageal detector devices. The American Heart Association International Guidelines 2000 Conference addressed this topic in detail to determine whether evidence now supports secondary confirmation devices as a required adjunct. Although no device or adjunct can substitute for proper visualization of the tracheal tube passing through the vocal cords, the devices for secondary confirmation still played an important role in difficult situations such as trauma.[27]

The quantitative end-tidal CO_2 detectors are widely accepted as the best, albeit most expensive, secondary confirmation device. A capnometer provides a single quantitative readout of the concentration of CO_2 at a single point in time, whereas the capnograph provides a continuous display of the level of CO_2 as it varies throughout the ventilation cycle. These monitors can confirm successful tracheal tube placement within seconds of an intubation attempt. Patient deterioration associated with declining clinical status or subsequent tracheal tube dislodgement can also be detected with these devices. Dislodgement is an adverse event that is alarmingly common during out-of-hospital transportation of a patient.[28-32]

In our report, five patients underwent awake application of LMA. Of them, three couldn't be confirmed the proper positioning by physical examination. It may have double meanings; the first is that there is a difficulty of primary confirmation of LMA positioning by physical examination because the device always covers both the airway (or glottic opening) and partially the esophagus. This hypothesis should be examined by radiographs or fluoroscopy. Capnogaphy is therefore to be recommended as routine or primary confirmation of LMA positioning. The second is that awake intubation itself may be a risk factor for dislodgement of LMA because of the patients still have intact gag reflex and may move anyway although cervical immobilization has been applied. The observation is especially important when the patients were applied LMA during transportation.

In summary, our preliminary experience demonstrated that capnography should be routinely used as the confirmatory method of LMA positioning.

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