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STUDENT CONTRIBUTION

The prehospital practitioner and the laryngeal mask airway: "Are you keeping up?"

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Abstract

The laryngeal mask airway (LMA) has gained recognition as an acceptable device for securing the airway of patients during anaesthesia and emergency airway management within the hospital environment. Furthermore, the LMA has been utilised by paramedics in the prehospital setting when endotracheal intubation is either unavailable (untrained personnel) or impossible (failed intubation). Numerous articles have been published debating different techniques of its use and modifications from its original inception. This paper offers a recent review of those articles and presents a balance for the reader to consume. A brief history of the LMA is given, as well as discussion on selection of size, use of a bite block, cuff pressures, the disposable LMA, the intubating LMA, the ProSeal LMA and using cricoid pressure with the LMA insitu.

Keywords: Laryngeal Mask Airway, LMA, review, prehospital, paramedic

Introduction

This article is aimed at prehospital care providers who may not peruse journals dedicated to the profession of anaesthesiology. It is in these journals that airway management and new technology are discussed, leading to a better awareness of changes in practice. In particular, the controlled environs of the operating theatre allow airway management devices to be studied. Once this is done, advancements may be transferred to the prehospital arena. Prehospital care is now strongly driven by evidenced based medicine. 'Evidence-based medicine de-emphasizes intuition, unsystematic clinical experience, and pathophysiologic rationale as sufficient grounds for clinical decision-making, and stresses the examination of evidence from clinical research' (1).

Airway management is an integral part of treating the seriously ill or injured patient and improvements in practice should be actively sought on a continued basis. One such area receiving a vast array of research is the Laryngeal Mask Airway (LMA). This paper will discuss the changes in practice that has evolved regarding the LMA.

History of the LMA

The inventor of the Classic reusable LMA (C-LMA), Dr Archie Brain, devised the airway to provide an alternative to the facemask for ventilation during surgical procedures. The LMA offers a relatively "hands-free" airway that does not require laryngoscopy for insertion, thereby minimising laryngeal trauma and unwanted laryngeal reflexes (2). Although it does not provide airway protection in non-fasted patients, the LMA is relatively easy to use and easy to teach. For these reasons, the LMA is endorsed by the Australian Resuscitation Council (3) and the American Society of Anesthesiologists (4) as a rescue airway (when intubation is not possible), and as a first line airway management device in those with limited airway management experience. Effective ventilation has been shown to be easier and more rapid using the LMA rather than the endotracheal tube, whether its use is by paramedics (5)or respiratory specialists (6).

The LMA revolutionised anaesthetic practice and has now been used in excess of 100 million patients (7) and is available in more than 80 countries throughout the world (8). The LMA has been widely accepted as a form of airway management in the prehospital environment (9-14) and has been studied in its use by nurses (15-17) and inexperienced personnel (18). It has been shown that insertion of the LMA is easier and is less likely to produce gastric insufflation, a common problem with facemask ventilation (17).

The LMA has now been referred to as the "gold standard" of the supraglottic devices and whilst other devices have found some success, most have struggled to find a place in either anaesthetic practice or the emergency setting (19).

Size selection

When the manufacturers first released the LMA there were limited sizes available. In contrast today, the C- LMA is available in eight sizes ranging from size 1 to size 6 (20). Since its inception, there has been much debate as to the best method of determining correct size. This debate has led to a change in clinical practice whereby ***weight related sizing*** remains unproven and ***gender-based strategy*** is the most appropriate (21). Previously a size 3 would have been used for women, now a size 4 is generally recommended. Similarly, men are most likely suited to a size 5 LMA, rather than the once recommended size 4 (7, 18, 22-25). Asai and Brimacombe (7), categorically state that the size 3 LMA should never be used in adults and '...it appears to be generally appropriate to choose a relatively large laryngeal mask and to inflate the cuff with the minimum effective volume'. However Voyagis, Batzioulis et al.(26), suggest that whenever an LMA cannot be inserted, a smaller size should be used.

Bite block

A common practice in both anaesthetics and the emergency setting is the use of a Guedel airway as a bite block with both the LMA and the endotracheal tube. Keller, Sparr et al., (27) found that the Guedel airway used in this manner caused a higher incidence of ventilatory problems, bleeding, hoarseness and sore throat than did the bite block made of gauze swabs rolled into a cylindrical shape. Alarmingly they concluded that the '... combination of LMA and Guedel airway probably prevents either from sitting in the correct position' (27). Both devices are designed to sit centrally within the oral cavity. The Laryngeal Mask Co. Ltd. emphatically states 'Do not use an oral Guedel airway as a bite-block'. Instead they suggest the use of three to four 10x10cm gauze pads (28). However the user should be alert as to the possibility of these pads being misplaced within the oral cavity

and causing airway obstruction, particularly in an uncontrolled environment. Taping the bite-block in place would eliminate this potential problem.

Insertion techniques

The insertion technique of the LMA has not changed dramatically since its inception with the '...practice of inserting the index finger to its fullest extent into the oral cavity until resistance is encountered...' (28), followed by a further thrust until the tip of the LMA reaches the hypopharynx. Asai and Morris (29), describe other methods such as; the lateral approach, rotation, jaw thrust, partially inflating the cuff (see below), and the use of the laryngoscope, but advise that '...none has proved to be better than the standard technique.' The new disposable Soft Seal Laryngeal Mask (30) has a thicker, stiffer tube and can be inserted by holding the device in a "pen like" fashion and thus does not require the operator to insert one's finger into the patient's mouth.

When inserting an LMA, the patient's head should be placed on a small pillow with the neck flexed and head extended to create the "sniffing position". The pillow increases alignment of the three anatomical axis of the airway, the oropharynx, pharynx and the larynx (21, 31, 32). The sniffing position is also used for preparation of endotracheal intubation.

Ease of insertion when using either the standard ***un-inflated*** cuff or the ***fully inflated*** cuff technique has also been studied (33) with the results showing no difference in first attempt success rate between the two techniques. Brain however, (cited in (34)) argues that the deflated cuff is necessary to negotiate the airway without collision of the epiglottis or arytenoids and prevention of entry into the larynx.

Cuff pressure

Current debate exists as to the correct cuff volume of air required to create an adequate seal (once the LMA is in place) without causing excessive pressure and likely mucosal damage to the hypopharynx. In practice, should the pressure on the pharyngeal mucosa exceed capillary perfusion pressure, ischaemia and tissue damage may ensue (35). Damage to hypoglossal**,** glossopharyngeal, lingual and recurrent laryngeal nerves have also been reported (36-41).

Increasing cuff volume does not relate to a better seal. In fact, Asai and Howell, et al. (22) found '…the minimum effective cuff volume was 3-20 ml for the size 3 LMA and 5-40 ml for size 5'. These figures represent a considerable reduction to those of the maximum pressures commonly used. Asai and Howell, et al.(22) determined that by reducing the volume of air in the cuff, pressure within the pharynx decreased significantly.

A "just seal" is preferable whereby the minimum amount of air is inflated into the cuff until an adequate seal around the mask is obtained. It should always be remembered that maximum volumes recommended are just that, ***maximum volumes***, and that these pressures should not be routinely used (42). The objective is to allow for adequate ventilation, whilst eliminating (as much as possible) gastric insufflation and regurgitation. High ventilation pressures (force of compression on resuscitation bag) relate to a strong increased risk of gastric insufflation. Pressures of between 19-33 cm H_20 (mean 28) have been shown to produce gastric filling (11).

Disposable LMA

Airway devices designed for multi use require time-consuming maintenance procedures such as cleaning and autoclaving. Furthermore, recent evidence has shown that even after these

efforts, cross infection of prions remains a risk (43-45). Recently, two single-use latex-free LMAs, both made from medical-grade Polyvinyl Chloride (PVC), have become available. The Laryngeal Mask Co. Ltd. released the Unique LMA (U-LMA) (8), whilst Portex Ltd. (30) released its version of disposable LMA called the Soft Seal Laryngeal Mask (SS-LM). Both devices are similar in dimensions as the C-LMA however the SS-LM differs in as much as it has a thicker cuff and stiffer tube and does not have aperture bars across its bowl. The disposable LMAs are impermeable to N_2O during administration and thereby cuff pressures remain stable, whereas cuff pressures can increase significantly in the reusable LMA (46).

Limited trials to date have shown little difference in ease of insertion, airway pressures, fibre optic positioning (47) or clinical performance (48) between the C-LMA and the U-LMA. However one report (49) proposed that the stiffness of the material of the U-LMA led to excessive difficulties with insertion (although there were only three cases cited) and the authors stated that they would not be prepared to use the disposable masks and have since reverted to the reusable C-LMA (49).

In a case reported by Spielman (50) device failure occurred when the shaft of the U-LMA became separated from the mask during an anaesthetic procedure. There were no adverse effects to the patient as a result of this failure and the manufacturer could give 'no definitive explanation' for the cause. This report gave a timely reminder to carefully inspect all equipment before use.

The SS-LM has been shown to be similar in first pass insertion rates and clinical acceptability as the C-LMA (51, 52). However in a recent audit (53), 76% of anaesthetists (of varying experience) rated it inferior to the C-LMA and more difficult to use.

To date, no clinical trials have been published on the use of disposable LMAs in the prehospital environment. A case presentation describes the U-LMA in use in an obese trauma patient where endotracheal intubation was deemed impossible (12). The U-LMA provided a valuable airway for the retrieval of the patient from the scene of the incident, throughout the air flight, until arrival at the trauma centre.

The intubating LMA

The Intubating Laryngeal Mask Airway (I-LMA) was bioengineered by Dr Brain to facilitate tracheal intubation without the requirement of laryngoscopy (blind intubation). The Laryngeal Mask Co. have produced the LMA-Fastrach™ (I-LMA) that can facilitate the passage of a size 8.0mm cuffed endotracheal tube (ETT). The Fastrach can be used like a standard LMA for ventilation and its handle provides easy insertion (8). (Refer Figure 1.) The specially designed ETT is passed through the I-LMA to a depth predefined on the tube, then, an extender tube is placed to facilitate removal of the I-LMA. Otherwise, the I-LMA cuff can be deflated and left in place once the ETT is in its place. Correct placement of the ETT is confirmed by standard intubation assessments such as; chest inflation, $ETCO^2$, SpO^2, tube condensation and chest auscultation. The I-LMA has recently been released in a disposable form but is currently only available in sizes 3, 4, and 5 (20).

Figure 1. The LMA-Fastrach™ (I-LMA) (http://www.lmaco.com/html/fastrach.html)

The success rate for blind intubation using the I-LMA has been shown to be greater than 90% (54, 55) however successful placement is not always on the first attempt (56). The I-LMA would seem suited in the prehospital setting as it not only provides adequate ventilation as a LMA, but also passageway for endotracheal intubation without the need for laryngoscopy. Recent out-of-hospital studies have confirmed this (57, 58).

The ProSeal™ LMA (P-LMA)

Further modifications to the C-LMA saw the introduction of the P-LMA. (Refer Figure 2.) Its design is similar to that of the LMA but with an integral drainage tube to facilitate venting (in the case of gastric insufflation) and suction of gastric fluid. Just like the classic LMA, it is designed to allow hands free ventilation but with a possible reduced risk of regurgitation. The P-LMA is not a replacement for the ETT and does not completely protect the airway.

The P-LMA may be inserted with a specifically designed introducer eliminating the need to place the fingers in the patient's mouth during insertion. Additionally, it has a built in bite-block. Currently, it is only available in the re-usable form in sizes 2, 3, 4, and 5 (28).

The P-LMA has been found to be more difficult to insert compared to the LMA with first insertion success rates of 86%, 77%, 85% and 82% (59-61).

Figure 2. The ProSeal™ LMA (P-LMA) (http://www.lmaco.com/html/proseal.html)

Airway sealing pressure has been found to be higher in the P-LMA than the LMA at all cuff volumes, (59, 61) making it more suitable for positive pressure ventilation (PPV). Furthermore, when the P-LMA is correctly positioned it facilitates gastric tube placement (59) and isolates the glottis from the upper oesophageus with possible implications for airway

protection (59). However one study (24) demonstrated that during PPV, oesophageal insufflation can occur simultaneously with venting from the drainage tube. The larynx is displaced anteriorly exposing the undersides of the arytenoid and cricoid cartilages, which may shift the cuff of the P-LMA laterally. This displacement allows the pyriform fossae to be exposed creating an easy passage for air to enter the oesophagus (24). The ability of the P-LMA to ***prevent*** or ***drain*** gastric regurgitation has yet to be determined (61).

Cricoid Pressure and the LMA

As previously mentioned, the C-LMA is a supraglottic device and as such does not protect the trachea from aspirate of gastric contents, or the stomach from insufflation of air during resuscitative efforts. Cricoid pressure (Sellick's manoeuvre) has been shown to be effective in decreasing the risk of regurgitation and/or gastric insufflation when using a face mask (62, 63), and even after placement of an LMA (64, 65). Cricoid pressure should be applied before insertion of the LMA and continued throughout resuscitative efforts, but if difficulty in correct placement occurs as has been reported (66-69) and disputed (70), then cricoid pressure should be temporarily released (71, 72). Similarly, ventilation through the LMA may be impaired by cricoid pressure (64, 66, 69, 73, 74), which would warrant reassessment of LMA positioning and correct application of cricoid pressure. Studies have revealed that many trained assistants apply cricoid pressure imperfectly (75, 76). Furthermore, cricoid pressure is a dedicated skill requiring the use of an additional rescuer often not available in the pre-hospital setting. Cricoid pressure should never be used during active vomiting.

Other supraglottic devices

Since the inception of the Classic reusable LMA, several other supraglottic devices have been developed in an attempt to capture a portion of the marketplace. Some devices maintain airway patency with a large oropharyngeal cuff that either seals or directs air towards/around the laryngeal inlet; (Cuffed Oropharyngeal Airway, Glottic Aperture Seal airway, PAXpress, Cobra, Elisha Airway Device), some are designed to occlude the oesophagus; (Laryngeal Tube, Esophageal Obturator Airway, Esophageal Gastric Tube Airway, Airway Management Device), one has a "sump-like" area to capture regurgitated fluid; (SLIPA, Streamlined Liner of the Pharyngeal Airway), whilst others "edge their bets" whether the leading tube rests within the oesophagus or the trachea; (Esophageal Tracheal Combitube, Pharyngotracheal Lumen Airway, Tracheoesophageal Airway).

Discussion

The LMA seems to have '...survived the 'major defect' stage, and to have entered the trial by morbidity stage' (77). This survival has seen the LMA endure rigorous research with subsequent publishing of findings for peer review. Unfortunately the uncontrolled environment that challenges the ambulance practitioner also presents difficulties in conducting research in the field. This is evident by the paucity of sound experimental prehospital-based studies available from which clinical practice can be governed. However a large portion of anaesthetic practice can be extrapolated for consideration in the prehospital environment. The author of this paper has explored current trends published in anaesthetic journals and presented them for review of prehospital LMA users. When making comparisons of the findings presented here, the reader is asked to consider the vast differences in each study presented. For example; whether the patient is paralysed/not paralysed; insertion method used; cuff pressure; size of LMA; position of patient and so on. Additionally, the majority of studies are from anaesthetic practice where the patient is intentionally anaesthetised and will therefore tolerate the insertion of an LMA. One of the

most common reasons of failed LMA insertion in the field is rejection from insufficiency comatose patients (9).

Finally, this paper does not include the ***LMA*** versus ***Endo Tracheal Intubation*** (ETI) debate that continues worldwide. But suffice to say that in order to perform endotracheal intubation, the operator requires a great deal of skill and the patient may be exposed to laryngeal trauma and hemodynamic changes from the process of laryngoscopy. Further, there are a number of patients whose anatomical differences make intubation at the very least extremely difficult, if not impossible; (e.g.; bull neck, prominent front teeth, immobile cervical spine and so on). Performing ETI has the potential for morbidity and mortality, whereas the LMA is an acceptable airway when ETI is unavailable or unable to be performed.

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