

Comparison of the VBM™ laryngeal tube and laryngeal mask airway for ventilation during manual in-line neck stabilisation

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ABSTRACT

Introduction: The purpose of this study is to assess whether the newly-developed VBM (Medizintechnik GmbH, Sulz, Germany) laryngeal tube (LT) is able to provide adequate ventilation and oxygenation to patients with an unstable neck and require airway management. The haemodynamic responses to insertion between the two devices were also studied. We compared the LT to the laryngeal mask airway (LMA) as an alternative airway management tool in adult patients with unstable neck and who underwent intubation with manual in-line neck stabilisation.

Methods: A randomised single-blinded prospective study was conducted involving a total of 40 American Society of Anesthesiology I and II pre-medicated patients who were divided into two groups, LT or LMA, for airway management during elective surgery. There were 20 patients for each group. After pre-oxygenation, anaesthesia was induced using intravenous (IV) fentanyl and IV propofol. The neuromuscular blockade was produced with either IV vecuronium or IV atracurium. The LT or LMA was inserted after neuromuscular blockade was confirmed using a peripheral nerve stimulator (train-of-four 1). A size 3, 4 or 5 LT or a size 3 or 4 LMA was inserted while the patient's head and neck were being stabilised by an assistant who held the sides of the neck and the mastoid processes (manual in-line stabilisation). If it was not possible to ventilate the lungs, or if end-tidal carbon dioxide and/or chest movement did not indicate a patent airway, the LT or LMA was removed. After three failed attempts, the study was terminated and the airway was secured in the most suitable

manner determined by the anaesthetist. After successful placement of LT or LMA, anaesthesia was maintained with 66 percent nitrous oxide in oxygen and 2 minimum alveolar concentration sevoflurane. All patients received standard anaesthesia monitoring. The ease of insertion, the number of attempts needed to successfully secure the airway, episodes of desaturation (less than 95 percent) and end-tidal carbon dioxide at various time intervals were studied. The haemodynamic parameters such as systolic blood pressure, diastolic blood pressure, mean arterial pressure and heart rate at different time intervals were also studied.

Results: The study showed a statistically significant difference in time required for successful insertion between the groups; time required for LT was 24.8 +/- 7.7 seconds and LMA was 36.1 +/- 17.3 seconds (p-value equals 0.01). Both groups had no statistical differences (p-value is greater than 0.05) in number of attempts needed to achieve a patent airway, and the successful insertion rate was 100 percent for both groups. There were also no statistical differences in the haemodynamic response to insertion and the end-tidal carbon dioxide in this study.

Conclusion: We conclude that, under anaesthesia, the LT was a valuable and better alternative to LMA for ventilation and airway management when the patient's head and neck are stabilised by the manual in-line method.

Keywords: airway management, anaesthetic equipment, cardiovascular system, difficult intubation, laryngeal mask, laryngeal tube

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INTRODUCTION

The laryngeal tube (LT) (VBM™, Medizintechnik GmbH, Sulz, Germany) is a new airway device that has recently been introduced into clinical practice. It has been developed to secure a patent airway during spontaneous breathing or controlled ventilation. The design of the laryngeal tube is based on the oesophageal obturator airway, and it is designed to be inserted blindly into the oesophagus. The LT consists of an airway tube with a small cuff attached to the tip (distal cuff) and a larger cuff to the middle of the tube (proximal cuff). The cuffs are inflated through a single pilot tube and balloon, through which the cuff can be monitored. There is a standard 15 mm connector on the proximal end of the device, so that it can be attached to a breathing system. The laryngeal tube device is made of silicone and is reusable after sterilisation. Two oval holes located between the cuffs allow lung ventilation.

When the device is inserted, it lies along the length of the tongue, and the distal tip is positioned in the hypopharynx. The proximal cuff provides a seal by forming a plug in the upper pharynx and the distal cuff seals the oesophageal inlet. A black line on the mid-part of the tube indicates adequate depth of insertion when aligned with the teeth. The tip is made of soft silicone to minimise oropharyngeal injury. Six sizes are available, suitable for neonates to adults⁽¹⁾. The LT has been shown to provide a clear airway during controlled ventilation in anaesthetised patients⁽²⁾, and has been suggested to have a potential role during cardiopulmonary resuscitation because of its ease of insertion and a good airtight seal⁽³⁻⁷⁾.

The use of the laryngeal mask airway (LMA) has become increasingly popular in anaesthesia for maintaining airway potency during spontaneous and controlled ventilation⁽⁸⁾. It has the advantage of not requiring laryngoscopy for insertion. The haemodynamic response to insertion of the LMA is significantly less than after laryngoscopy and tracheal intubation^(9,10). These responses may be harmful in patients with cardiovascular and cerebral diseases. In patients with unstable necks, the head and the neck need to be stabilised manually (manual in-line stabilisation), but it is not known whether this procedure affects the ease of insertion of the LT. In a patient with an unstable neck, airway management may be required while the patient's occiput is placed directly on the trolley and the head and neck are stabilised manually (manual in-line stabilisation).

The manufacturer of the LT claims that, although insertion of the device is best achieved when the neck is flexed and the head extended (Magill position or sniffing position)⁽¹¹⁾, it can be inserted in any given

position of the head. There have been several reports that studied the ease of the insertion of various forms of the LMA⁽¹²⁻¹⁶⁾. A few studies have concluded that insertion of the LMA classic becomes more difficult when the patient's head and neck are stabilised, but it is often possible to ventilate the lungs through it^(12,14). In this study, we compared the ease of insertion and the haemodynamic response to insertion between the LT and LMA during manual in-line neck stabilisation.

METHODS

A randomised single-blinded prospective study was conducted involving a total of 40 American Society of Anesthesiology (ASA) I and II pre-medicated patients, aged 18-65 years, who were divided into two groups, LT and LMA, for airway management during elective surgery. There were 20 patients in each group. The grouping was randomised by drawing from sealed opaque envelopes containing the letters LT or LMA, and with the power of study of 80%. Exclusion criteria included patients at risk of pulmonary aspiration of gastric contents and those with features suggestive of possible difficult intubation (e.g. Mallampati III-IV classification⁽¹⁷⁾, a receding chin, protruding front teeth and limited neck extension).

After pre-oxygenation, anaesthesia was induced using intravenous (IV) fentanyl (Hameln Pharmaceuticals GmbH, Langes Feld, Hameln, Germany) (1.5 µg/kg body weight) and IV propofol (AstraZeneca Pharmaceuticals, Wilmington, DE, USA) (2 mg/kg body weight). The neuromuscular blockade was produced with either IV vecuronium (NV Organon, Oss, Holland) (0.1 mg/kg body weight) or IV atracurium (GlaxoSmithKline, USA) (0.5 mg/kg body weight). The LT or LMA was inserted after neuromuscular blockade was confirmed using a peripheral nerve stimulator (train-of-four [TOF] 1). A size 3, 4 or 5 LT or a size 3 or 4 LMA was inserted while the patient's head and neck were being stabilised by an assistant who held the sides of the neck and the mastoid processes (manual in-line stabilisation). If it was not possible to ventilate the lungs, or if end-tidal carbon dioxide (ETCO₂) and/or chest movement did not indicate a patent airway, the LT or LMA was removed. After three failed attempts, the study was terminated and the airway was secured in the most suitable manner determined by the anaesthetist.

After successful placement of LT or LMA, anaesthesia was maintained with 66% nitrous oxide (NO₂) in oxygen (O₂) and 2 minimum alveolar concentration (MAC) sevoflurane. All patients received standard anaesthesia monitoring. Ease

of insertion, which included the time required to successfully insert the airway device, episodes of oxygen desaturation (<95%), abandonment of technique and the number of attempts needed to achieve a patent airway, were recorded. Time to successful insertion was defined as the duration from the removal of the facemask to successful delivery of the first tidal volume. The haemodynamic parameters (systolic blood pressure, diastolic blood pressure, mean arterial pressure, and heart rate) were measured and recorded prior to induction, after induction and two minutes after insertion of devices. The ETCO₂ were recorded at one, three, and five minutes after insertion of devices.

Results were presented as mean and standard deviation (SD) or mean and percentile. The Statistical Package for the Social Science (SPSS) version 11.5 for Windows (Chicago, IL, USA) was used in statistical analysis. The data from the two groups were analysed using the independent t-test for continuous variables or the chi-square for categorical data. Haemodynamic data were analysed using analysis of variance (ANOVA) for repeated measurements. Differences were considered statistically significant when p<0.05.

RESULTS

The patients' characteristics are shown in Table I. The two groups were well matched. There was

Table I. Characteristics of patients.

Parameter	LT group (n=20)	LMA group (n=20)	p-value
Age (years)	40.0 (13.9)	37.1 (14.1)	0.512
Weight (kg)	56.5 (8.8)	58.9 (11.7)	0.483
Height (cm)	160.2 (8.2)	160.8 (6.6)	0.818

Values are given as mean (SD).

Table II. Time to successful insertion of device, number of insertion attempts and rate of successful insertion.

Parameters	LT group (n=20)	LMA group (n=20)	p-value
Time to successful insertion (seconds)	24.8 (7.7)	36.1 (17.3)	0.01
Number of attempts			
1	20	17	0.198
2	-	2	
3	-	1	
>3	-	-	
Successful insertion			
yes: no	20:0 (100%)	20:0 (100%)	-

Values are given as mean (SD).

a statistically significant difference in the time required for successful insertion between the groups (Table II). The time required was 24.8 ± 7.7 seconds for LT and 36.1 ± 17.3 seconds for LMA (p=0.01). Both groups had no statistical difference (p>0.05) in the number of attempts needed to achieve a patent airway although we were able to achieve a clear airway in all (100%) patients in the LT group at the first attempt compared with 85% in the LMA group (Table II). The successful insertion rate was 100% for both groups (Table II). Ventilation through the LT and LMA was adequate in all 40 patients (100%) when patient's head and neck were placed by manual in-line stabilisation. Haemodynamic data are presented in Figs. 1-4. There were no differences in the systolic blood pressure, diastolic blood pressure, mean arterial pressure, heart rate and ETCO₂ (Fig. 5) between the two groups (by ANOVA for repeated measurements).

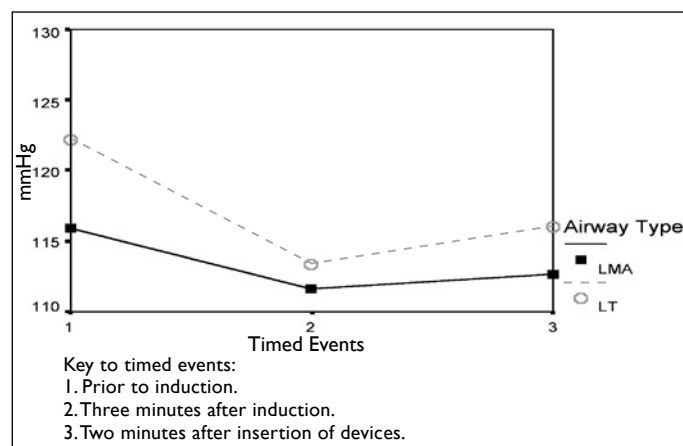


Fig. 1 Systolic blood pressures at different time intervals. There was no significant difference between the two groups (p=0.717).

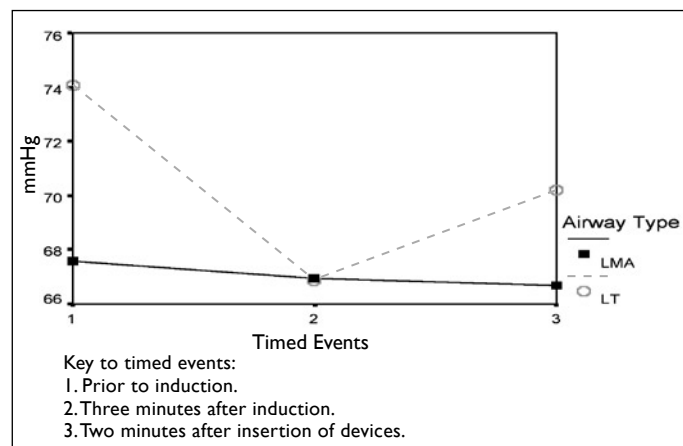


Fig. 2 Diastolic blood pressures at different time intervals. There was no significant difference between the two groups (p=0.242).

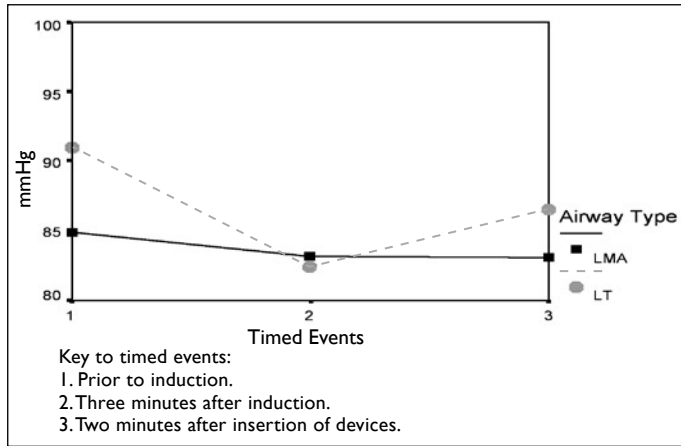


Fig. 3 Mean arterial pressures at different time intervals. There was no significant difference between the two groups ($p=0.300$).

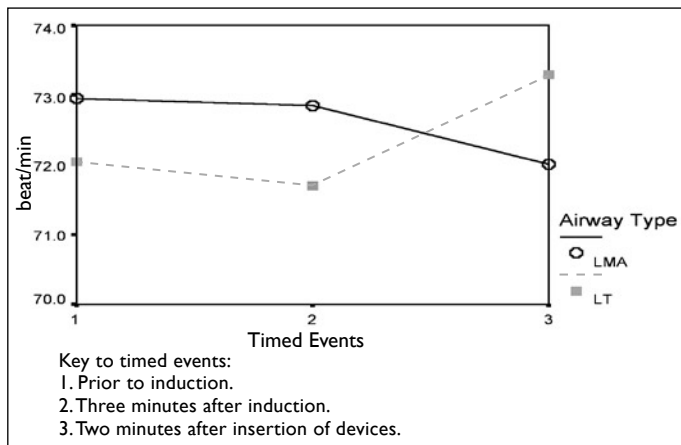


Fig. 4 Heart rate at different time intervals. There was no significant difference between the two groups ($p=0.570$).

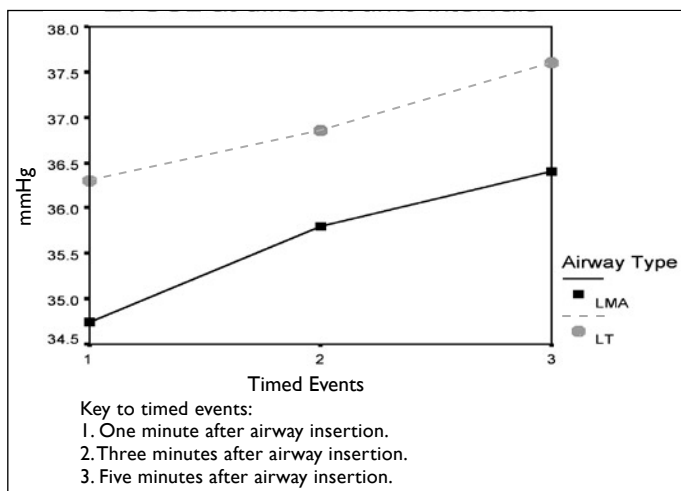


Fig. 5 End-tidal carbon dioxide (ETCO₂) at various time intervals. There was no significant difference between the two groups ($p=0.887$).

DISCUSSION

Laryngoscopy and tracheal intubation during anaesthesia are frequently associated with transient hypertension, tachycardia and arrhythmias⁽¹⁸⁾. These

haemodynamic responses reflect the increase in sympathetic and sympathoadrenal activity in response to oropharyngeal, laryngeal and tracheal stimulation⁽¹⁹⁾. Wood and Forrest recommended the use of the LMA as a means of avoiding the haemodynamic response to tracheal intubation in circumstances where such a response might be undesirable⁽¹⁰⁾. Chiu et al's study involved 60 patients and revealed no significant statistical difference in haemodynamic responses for both LT and LMA groups⁽²⁰⁾. The aim of this study was to evaluate and to compare the haemodynamic responses while using the LT or LMA during manual in-line neck stabilisation. In this study, there was a decrease in systolic blood pressure after three minutes of induction from baseline for both groups; but it was not statistically significant ($p=0.319$). The decrease in systolic blood pressure after the induction could be explained by the intravenous drugs used for the induction, which were 2 mg/kg of propofol and 1.5 μ g/kg of fentanyl. In the absence of NO₂, propofol per se can reduce the blood pressure by a mean of 20% in cardiac output and 22% in stroke volume.

Apart from systolic blood pressure measurement, other haemodynamic parameters were also tested in the study and they included diastolic blood pressure, mean arterial pressure and heart rate. Although all of the parameters in both groups showed some reductions in measurements after induction, they were not statistically significant. Obviously all the haemodynamic values were not increased at two minutes after airway insertion compared to baseline readings. Based on these findings, we can say that the LT was comparable with the LMA in terms of less haemodynamic responses after intubation, which has been proven in many studies for LMA. This study showed that there was statistically significant difference between the groups in the time required for successful insertion. The time required for LT was 24.8 ± 7.7 seconds and for LMA, 36.1 ± 17.3 seconds ($p=0.01$). Both groups had no statistical differences ($p>0.05$) in the number of attempts needed to achieve a patent airway, although we were able to achieve a clear airway in all (100%) patients in the LT group at the first attempt compared with 85% in the LMA group. This finding was in agreement with the previous studies done by Asai et al⁽²¹⁾ and Dorges et al⁽⁴⁾, where they achieved 100% success rate with one attempt for LT. The successful insertion rate was 100% for both groups.

Ventilation through the LT and LMA were adequate in all 40 patients (100%) when the patient's head and neck were placed by manual in-line stabilisation. None of the patients had an

episode of desaturation (<95%) during this study. There was no significant difference between the two groups for the ETCO_2 at three different time intervals. Looking at the results, we conclude that the LT was easier to insert, able to provide adequate ventilation and oxygenation, and was as effective as LMA in maintaining the haemodynamic response to insertion. A reduced haemodynamic effect response may be beneficial in patients with cardiovascular and cerebral diseases. We conclude that the LT is a suitable alternative to the LMA for airway management, when the patient's head and neck are stabilised by manual in-line method.

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