

The laryngeal tube – a helpful tool for cardiopulmonary resuscitation in the dental office?

G. Keilholz¹ and T. S. Mutzbauer^{*1,2}

IN BRIEF

- The laryngeal tube may provide beneficial effects during ventilation within CPR administered by dental staff.
- Lay rescuers, as well as inexperienced professional first responders, must be instructed to continue chest compression during insertion of supraglottic airway adjuncts such as the laryngeal tube.

Background Supraglottic airway adjuncts such as the laryngeal tube (LT) have been recommended to be used by cardiopulmonary resuscitation (CPR) first responders. **Objective** This study aims to evaluate the performance characteristics of dental students and dentists using the LT in comparison to a conventional bag valve mask device (BVM) within manikin CPR training. **Method** A group of eight dentists and 12 dental students performed randomised crossover CPR training using LT and BVM. Time intervals needed to perform five CPR cycles were recorded, as well as tidal and total gastric inflation volumes. **Results** Median tidal volumes 0–1025 ml (median 462.5 ml) were observed using BVM and 100–500 ml (median 237.5 ml) with LT ($p = 0.02$). Total gastric inflation of 0–2900 ml was measured using BVM, no gastric inflation using LT ($p = 0.0005$). Time intervals needed to perform five CPR cycles did not differ between BVM (range 87.5–354.5 s, median 112 s) and LT (range 84.7–322.3 s, median 114 s) ($p = 0.55$). A median delay of 37.6 s (range 0–82.1 s) before starting CPR was observed using LT. **Conclusions** Lower tidal volumes but also lower or even no gastric inflation may be observed when dentists use a laryngeal tube during CPR. Respective training must focus on chest compressions. These must be started before inserting the LT or a different supraglottic airway adjunct and be delivered continuously during insertion. It is recommended to use a supraglottic airway such as an LT only after having been trained in its use.

INTRODUCTION

Cardiac arrest is an emergency that is assumed to occur rarely in dental offices.^{1,2} However, medical emergencies in general may not be as rare in dental facilities.¹ As dentists are usually inexperienced rescuers, basic life support measures should be applied by this population. However, it has been suggested for lay rescuers to use automated external defibrillators.³ Educated dentists may use additional airway adjuncts during resuscitation.⁴

Ventilation during cardiopulmonary resuscitation (CPR) is a difficult task – not only for the inexperienced rescuer. Airway adjuncts such as the laryngeal tube (LT), a supraglottic airway, have been found to reduce the so called ‘no flow time’⁵ as chest compressions can be continued during ventilation phases within CPR.⁴ Performance analysis

of the LT used by inexperienced paramedic students had revealed higher tidal volumes compared to conventional bag valve mask (BVM) ventilation.⁶

The aim of this pilot study was to evaluate the LT as a treatment adjunct for ventilation during CPR training of dentists and dental students. The LT is available in different versions, as a re-usable or a disposable device. One of the versions is equipped with a ventilation channel and a separate channel enabling the use of an additional gastric tube (Fig. 1). The standard re-usable LT without additional gastric tube channel connected to a bag valve combination was compared to a conventional BVM ventilation device.

Three null hypotheses were tested:

- There would be no differences in tidal volumes using the LT compared to the conventional BVM ventilation device
- There would be no differences in gastric inflation volumes when using the respective devices
- There would be no differences in the time intervals needed to perform a given number of resuscitation cycles using either device.

METHODS

The study participants were dental students and dentists having been educated in

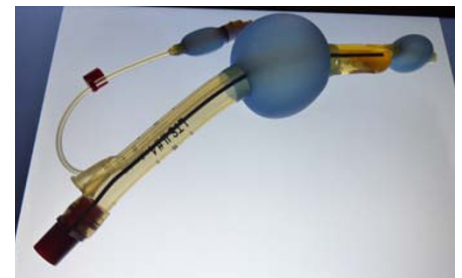


Fig. 1 Laryngeal tube (LT) in the re-usable version (LTS) with a separate channel to be used with a gastric tube. The version used in the present evaluation was the re-usable LT without the separate channel

emergency medical procedures more than six months before the test. None of the test persons had performed a real cardiopulmonary resuscitation procedure before the test, nor had any of the test persons used a laryngeal tube before in a manikin or a real patient.

All participants performed CPR tests on a manikin using two ventilation devices in a randomised crossover design. For ventilation, the participants used either a conventional breathing bag connected to a face mask size three, or a similar bag connected to a laryngeal tube size five, after this had been inserted into an airway management training simulator. Tidal volumes as well as gastric inflation volumes were measured by airway and oesophageal volumeters (Fig. 2).

¹Mutzbauer & Partner, Maxillofacial Surgery and Dental Anaesthesiology, Tiefenhoefe 11, CH-8001 Zürich, Switzerland; ²Institute for Anatomy and Cell Biology, University of Heidelberg, Im Neuenheimer Feld 307, D-69120, Heidelberg, Germany
*Correspondence to: Dr Till S. Mutzbauer
Email: mutzbauer@gmail.com
Tel: +41 44 211 1465

Only two participants at a time were allowed to enter the room of the test and both performed their tasks in a crossover design. All participants had received a standardised instruction on how to use the laryngeal tube correctly and were allowed to familiarise themselves with the mechanism of air inflation into the cuffs of the device before the test. The tidal volumes, the gastric inflation volumes per breath, as well as the times needed to perform five cycles of CPR were recorded.

As the data had been obtained within regular training schedules, ethics committee approval had been waived after a respective request to the board.

Written informed consent had been obtained by all study participants.

Statistical analysis

Data were collected within a Microsoft Excel spreadsheet and later analysed with the Excel add-in Analyse-it (version 2.30).

The two-tailed Wilcoxon test for matched pairs was used to compare the distribution of median tidal volumes and total gastric inflation volumes observed within the test, as well as the time intervals to perform five cycles of CPR. Data distributions were considered statistically different at *p* values lower than 0.05.

RESULTS

Twenty (11 female, nine male) participants were included - twelve were dental students (two having finished medical school) and eight were dentists.

The calculated range of the median tidal volumes using the conventional BVM device were between 0–1,025 ml (median 462.5 ml), whereas a range of 100–500 ml (median 237.5 ml) was observed when an LT was used (*p* = 0.02). Using BVM, three participants were not able to ventilate. Using LT these three individuals were able to administer tidal volumes between 50–250 ml. 42.5% of ventilations with BVM resulted in tidal volumes lower than 500 ml, 26.5% higher than 600 ml. Using the LT, 94% of all tidal volumes were below 500 ml.

Between 0–2,900 ml total gastric inflation volumes were measured during five cycles of CPR using the conventional BVM device, whereas no gastric inflation at all was observed during ventilation with the LT during CPR (*p* = 0.0005).

The time intervals needed to perform five cycles of CPR using the conventional BVM device (range 87.6–354.5 s, median 112 s) did not differ when comparing these to CPR using the LT (range 84.7–322.3 s, median 114 s) (*p* = 0.55). Using the LT a median delay of 37.6 s (range 0–82.1 s)

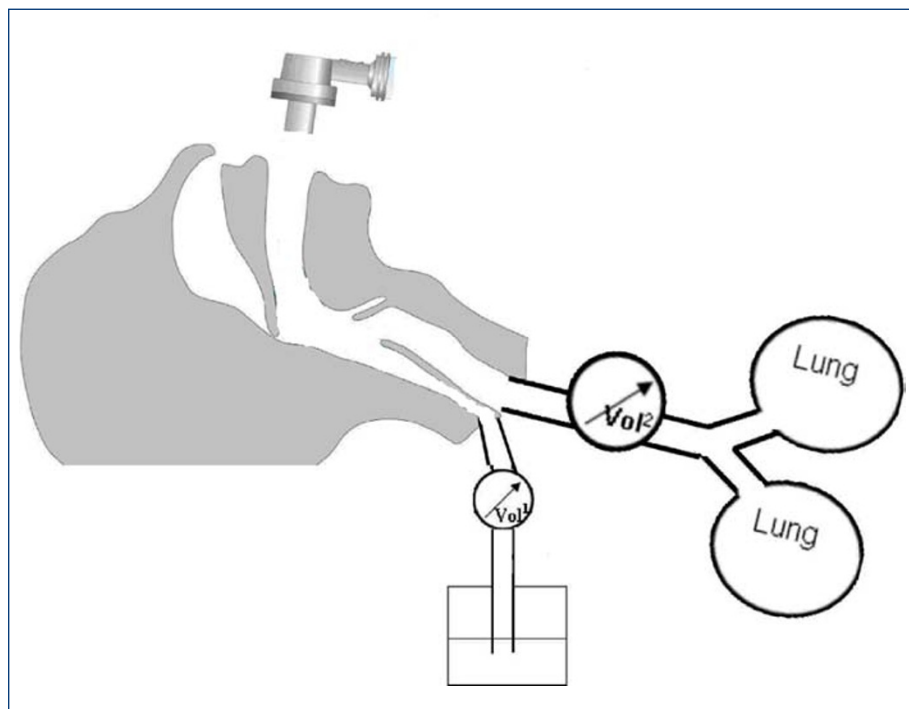


Fig. 2 Test device connected to an AmbuMan training manikin. Vol 1: volumeter measuring gastric inflation volume; Vol 2: volumeter measuring tidal volume. The manikin face was ventilated with a conventional bag valve mask device, the 'Bill' test device was ventilated with the laryngeal tube after insertion into the pharynx of the 'Bill' using the same bag valve device

was observed before chest compressions were started.

DISCUSSION

This pilot study was conducted to evaluate the LT regarding the achieved tidal and gastric inflation volumes during CPR simulation. Furthermore, a possible reduction of 'no flow time' intervals by adjunctive use of the LT should be examined.

Tidal volumes were lower when comparing the LT with the conventional BVM; even if participants used both hands to compress the bag during LT ventilation and only one hand could be used during BVM ventilation. Severe leaks when trying to provide an airtight seal to the face of the manikin using the BVM device were not observed.

It can be shown that gastric inflation may be lower or even excluded when the LT is used for ventilation in a cardiac arrest simulation compared to ventilation with a conventional BVM system. This result is in accordance with other studies and with the reality.^{7–9}

During five cycles of CPR 150 chest compressions and ten ventilations have to be administered. One hundred compressions per minute are recommended. Applying this rate, 90 seconds would be needed for 150 compressions. The rescuer should take no longer than one second per breath. Therefore, ten ventilations would require ten seconds. This calculation would result in a total time of 100 seconds for five CPR cycles. Using

the conventional BVM 9/20 and using the LT 6/20 individuals needed between 90–110 seconds. Using BVM 10/20 and using the LT 12/20 individuals needed longer than 110 seconds for five CPR cycles. This means that approximately 50% of CPR procedures using both devices were delivered slower than recommended.

However, the LT caused a delay in starting chest compression in 18 out of 20 individuals. The median delay was 37 seconds, which is in accordance with the insertion times of the LT found in other studies.¹⁰ It would have been expected that a reduction of 'no flow time' by use of the supraglottic airway adjunct should have led to reduced time intervals needed to perform five cycles of CPR in comparison to the use of the conventional BVM device.^{10–12} The dental student and dentist participants had been instructed beforehand that they should attempt to deliver chest compressions continuously and not to interrupt chest compressions during ventilation once the LT had been inserted.⁴ However, all but two study participants - both in one team - started chest compression activities after the LT had been inserted. It is not clear if these two rescuers would have delivered their CPR efforts similarly when working with other partners during CPR. The delays observed when rescuers used the LT in the present study can be explained by one rescuer waiting for the correct LT placement of the other rescuer before starting chest compressions. Furthermore, all teams had forgotten

Table 1 Comparison of ventilation performance of 20 dental students/dentists using a conventional bag valve mask (BVM) device and a laryngeal tube (LT) during five CPR cycles. 75Q: 3rd quartile, 25Q: 1st quartile

	Tidal volume [ml]		Total gastric inflation [ml]		Time for 5 CPR cycles [s]		Delay LT [s]
	BVM	LT	BVM	LT	BVM	LT	LT
Max	1025.0	500.0	2900.0	0	354.5	322.3	82.1
75Q	531.3	318.8	750.0	0	175.9	179.4	48.5
Median	462.5	237.5	520.0	0	112.0	113.7	37.6
25Q	146.9	175.0	0.0	0	99.2	105.3	26.0
Min	0.0	100.0	0.0	0	87.6	84.7	0.0
Mean	403.8	265.0	520.0	0	145.4	142.0	36.7
SD	286.7	116.9	763.3		67.7	63.1	20.0
p-value	0.02		0.0005		0.55		

the instruction that chest compressions and ventilation should be administered simultaneously when a supraglottic airway device is in use. This was perhaps due to following strict instructions from their previous training, focusing on intermittent ventilation to avoid gastric inflation. Performing CPR while using a supraglottic airway may have a lower efficiency as intended and named 'reduced no flow time'¹⁰⁻¹³ when non-professional rescuers, or even lay persons, use these devices if chest compressions are not started immediately after cardiac arrest has been diagnosed, and if ventilation and chest compressions are not performed simultaneously.

According to the recommendations from the UK Resuscitation Council on the treatment of medical emergencies in dental facilities, oropharyngeal but not supraglottic airways are included in the suggested minimum equipment list.^{14,15} Application of an oropharyngeal airway may, as well as inserting a supraglottic airway, delay chest compressions. Therefore, chest compressions during insertion of an oropharyngeal airway must be continued. According to the UK Resuscitation Council, a two-rescuer technique is recommended during BVM ventilation. This technique may further enhance tidal volume; however, higher pressure applied by using two hands for BVM ventilation may also bear the risk of gastric inflation.

Taken together, inexperienced rescuers, first responders, as well as dentists willing to use a supraglottic airway such as the LT during CPR, have to undergo specific training focusing on the uninterrupted chest compression activity before these devices are used for ventilation. Furthermore, chest compressions have to be continued during ventilation through a supraglottic airway, once in place, to reduce or even exclude the 'no flow time'. The bag should be compressed with both hands once the LT is in place. In the present study the participants

were debriefed after having finished the test and performed the procedure again to avoid delays in the future.

Limitations

The group of test persons was assumed to be homogenous regarding their CPR experience from training. However, undetected bias as communication between individuals having passed the test with others before entering the test cannot be excluded.

The short introduction into the use of a laryngeal tube was assumed to simulate residual knowledge of an individual having undergone a training session at a certain time interval before the actual emergency procedure. However, there was no real emergency situation and the test subjects were prepared to participate in a test. Furthermore, in reality airway adjuncts may not be immediately available at the place of the emergency. In this case chest compressions might have been either started without the supraglottic airway and/or a BVM device, or the delay might have even been longer as chest compressions may have been started only after availability of these adjuncts. Additionally, pulmonary compliance during cardiac arrest changes over time, resulting in reduced tidal volumes.¹⁶ Stomach inflation may be facilitated due to decreasing lower oesophageal sphincter opening pressure which has been observed to occur soon after cardiac arrest in animals as well as in humans.^{17,18} Direction of gas into the stomach may, therefore, be more likely in a later stage of CPR. In reality stomach inflation may be higher during BVM ventilation. The advantage of reduced or excluded stomach inflation by using supraglottic airways as the LT may therefore be more obvious in patients with cardiac arrest undergoing CPR, if the suggested airway pressure limit of 35 mmHg – in case of the LT – is not exceeded.¹⁹

The facial surface of the manikin simulated a normal adult. Edentulous patients,

however, usually have a facial contour that makes it more difficult to achieve an air tight mask seal to the face. Although it has not been tested in the examined study population, it has to be assumed that during BVM ventilation higher mask leaks would have resulted in lower tidal volumes, as well as in reduced gastric inflation volumes in edentulous resuscitation victims.²⁰

Standardised training concepts including supraglottic airway adjuncts as the LT have been provided successfully for emergency medical technicians and first responders.^{21,22} Similar or modified concepts may also be developed for dentists.

CONCLUSIONS

In this study, two ventilation techniques were employed by dental students and dentists during CPR training. It may be concluded that lower tidal volumes as well as also lower or even no gastric inflation may be observed when dentists use a laryngeal tube during CPR.

There is more emphasis on circulation in the current CPR guidelines. During insertion of an LT, a different supraglottic airway or an oropharyngeal airway, chest compressions must not be interrupted. Once the LT is in place, chest compressions should be continued during ventilation. Supraglottic airways such as an LT should be used by the dental team only after having been trained in their use.

1. Müller M P, Hänsel M, Stehr S N, Weber S, Koch T. A state-wide survey of medical emergency management in dental practices: incidence of emergencies and training experience. *Emerg Med J* 2008; **25**: 296-300.
2. Atherton G J, McCaul J A, Williams S A. Medical emergencies in general dental practice in Great Britain. Part 1: their prevalence over a 10-year period. *Br Dent J* 1999; **186**: 72-79.
3. Koster R W, Baubin M A, Bossaert L L et al. European Resuscitation Council Guidelines for Resuscitation 2010 Section 2. Adult basic life support and use of automated external defibrillators. *Resuscitation* 2010; **81**: 1277-1292.

4. Nolan J P, Soar J, Zideman D A *et al*. European Resuscitation Council Guidelines for Resuscitation 2010 Section 1. Executive summary. *Resuscitation* 2010; **81**: 1219–1276.
5. Wiese C H R, Bartels U, Bergmann A, Bergmann I, Bahr J, Graf B M. Using a laryngeal tube during cardiac arrest reduces 'no flow time' in a manikin study: a comparison between laryngeal tube and endotracheal tube. *Wien Klin Wochenschr* 2008; **120**: 217–223.
6. Kurola J, Harve H, Kettunen T *et al*. Airway management in cardiac arrest: comparison of the laryngeal tube, tracheal intubation and bag-valve mask ventilation in emergency medical training. *Resuscitation* 2004; **61**: 149–153.
7. Stohler F C, Becker M F, Tabacek G, Drommer R B, Mutzbauer T S. Alternative concept of ventilation during cardiopulmonary resuscitation (CPR) in dental chairs. *Schweiz Monatsschr Zahnmed* 2007; **117**: 814–819.
8. Esa K, Azarinah I, Muhammad M, Helmi M A, Jaafar M Z. A comparison between Laryngeal Tube Suction II Airway and Proseal Laryngeal Mask Airway in laparoscopic surgery. *Med J Malaysia* 2011; **66**: 182–186.
9. Amini A, Zand F, Sadeghi SE. A comparison of the disposable vs the reusable laryngeal tube in paralysed adult patients. *Anaesthesia* 2007; **62**: 1167–1170.
10. Wiese C H R, Bartels U, Schultens A *et al*. Influence of airway management strategy on 'noflowtime' during an 'advanced life support course' for intensive care nurses – a single rescuer resuscitation manikin study. *BMC Emerg Med* 2008; **8**: 4.
11. Wiese C H R, Bahr J, Bergmann A, Bergmann I, Bartels U, Graf B M. Reduction in no flow time using a laryngeal tube: comparison to bag-mask ventilation. *Anaesthesist* 2008; **57**: 589–596.
12. Wiese C H R, Bartels U, Schultens A *et al*. Using a laryngeal tube suction-device (LTS-D) reduces the "no flow time" in a single rescuer manikin study. *J Emerg Med* 2011; **41**: 128–134.
13. Wiese C H R, Bahr J, Popov A F, Hinz J M, Graf B M. Influence of airway management strategy on 'noflowtime' in a standardised single rescuer manikin scenario (a comparison between LTS-D and I-gel). *Resuscitation* 2009; **80**: 100–103.
14. Jevon P. Updated guidance on medical emergencies and resuscitation in the dental practice. *Br Dent J* 2012; **212**: 41–43.
15. Resuscitation Council (UK). *Minimum equipment list for CPR: primary dental care*. London, Resuscitation Council UK, 2013. Online information available at http://www.resus.org.uk/pages/QSCPR_PrimaryDentalCare_EquipList.pdf (accessed March 2015).
16. Ornato J P, Bryson B L, Donovan P J, Farquharson R R, Jaeger C. Measurement of ventilation during cardiopulmonary resuscitation. *Crit Care Med* 1983; **11**: 79–82.
17. Bowman F P, Menegazzi J J, Check B D, Duckett T M. Lower esophageal sphincter pressure during prolonged cardiac arrest and resuscitation. *Ann Emerg Med* 1995; **26**: 216–219.
18. Gabrielli A, Wenzel V, Layon A J, von Goedecke A, Verne N G, Idris A H. Lower esophageal sphincter pressure measurement during cardiac arrest in humans: potential implications for ventilation of the unprotected airway. *Anesthesiology* 2005; **103**: 897–899.
19. Dengler V, Wilde P, Byhahn C, Mack M G, Schalk R. Prehospital airway management of laryngeal tubes. Should the laryngeal tube S with gastric drain tube be preferred in emergency medicine?. *Anaesthesist* 2011; **60**: 135–138.
20. Schnider N, Grätz K W, Mutzbauer T S. Rescue mask with prefabricated leak for reduction of accidental stomach inflation during lay rescuer ventilation. *Open Emerg Med J* 2010; **3**: 17–20.
21. Schalk R, Auhuber T, Haller O *et al*. Implementation of the laryngeal tube for prehospital airway management: training of 1,069 emergency physicians and paramedics. *Anaesthesist* 2012; **61**: 35–40.
22. Länkimäki S, Alahuhta S, Kurola J. Feasibility of a laryngeal tube for airway management during cardiac arrest by first responders. *Resuscitation* 2013; **84**: 446–449.