



Original Contribution

The laryngeal tube device: a simple and timely adjunct to airway management

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Abstract

Introduction: Endotracheal intubation (ETI) is a motor skill that demands practice. Emergency medical service providers with limited intubation experience should consider using airway adjuncts other than ETI for respiratory compromise. Prehospital ETI has been recently interrogated by evidence exposing worsened patient outcomes. The laryngeal tube (LT) airway was approved by the Food and Drug Administration in 2003 for use in the United States. Using difficult airway-simulated models, we sought to describe the time difference between placing the ETI and LT and the successful placement of each adjunct in varied levels of healthcare providers.

Methods: Emergency medicine resident physicians, fourth year medical students, and paramedic students were asked to use both ETI and the LT. Subjects were timed (seconds) on ETI and LT placement on 2 different simulators (AirMan and SimMan; Laerdal Co, Wappingers Falls, NY). After ETI was complete, they were given 30 seconds to review an instructional card before placement of the LT. We measured placement time and successful placement of the device for ETI vs LT. Successful placement in the manikin was defined by a combination of breath sounds, chest rise, and absence of epigastric sounds.

Results: Overall mean placement time in the AirMan and SimMan for ETI was 76.4 (95% confidence interval [CI], 63.3–89.5) and 45.9 (95% CI, 41.0–50.2) seconds, respectively. Mean placement time for the LT in the AirMan and SimMan was 26.9 (95% CI, 24.3–29.5) and 20.3 (95% CI, 18.1–22.5) seconds, respectively. The time difference between ETI and LT for both simulators was significant ($P < .0001$). Successful placement of the LT compared with ETI in the AirMan was significant ($P = .001$).

Conclusions: A significant time difference and simplicity exists in placing the LT, making it an attractive device for expeditious airway management. Further studies will need to validate the LT effectiveness in ventilation and oxygenation; however, its uncomplicated design allows for successful use by a variety of healthcare providers.

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1. Introduction

Endotracheal intubation (ETI) is a difficult technical motor skill that requires frequent practice to maintain proficiency. Nationally, many paramedic advanced life support systems use ETI with or without rapid sequence

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KLTD Size	3	4	5
CONNECTOR COLOR	Yellow	Red	Purple
RECOMMENDED PATIENT HEIGHT	4-5 feet (155-180 cm)	5-6 feet (155-180 cm)	greater than 6 feet (180 cm)
ITEM #	KLTD203	KLTD204	KLTD205
O.D./I.D.	14 mm/10 mm	14 mm/10 mm	14 mm/10 mm
CUFF PRESSURE	60 cm H ₂ O	60 cm H ₂ O	60 cm H ₂ O
CUFF VOLUME	45-60 ml	60-80 ml	70-90 ml
Maximum Size Fiberoptic Bronchoscope (7.0 mm O.D.) Maximum Size Tube Exchange Catheter (19 Fr)			

Fig. 1 King laryngeal tube size chart. Reprinted with permission from King Systems Corp.

intubation (RSI). Evidence exists that supports the ability of paramedics to perform RSI [1], and it is currently taught in the national paramedic curriculum [2]. Recently, these protocols have come under scrutiny on a large scale, and several points of concern have emerged. Prehospital time to intubation appears to be problematic especially in the urban setting. A review of 893 ETI attempts in an urban setting from 2001 revealed an overall success rate of 86% (771/893) and a median time to intubate of 5 minutes for cardiac arrest patients and 17 minutes for non-cardiac arrest patients undergoing ETI [3]. Recent evidence points to increased morbidity and mortality after endotracheal intubation by prehospital providers. [4-7] Factors further complicating and worsening outcomes are tube dislodgement, incorrect placement, or the failure to recognize those complications [4,5]. Hence, more efficient, timely, and practical devices are sought to provide prehospital airway management in patients with respiratory compromise.

One such device is the King laryngeal tube (LT) (King Systems Corp, Noblesville, IN) [8] The LT was developed in Germany and approved by the Food and Drug Administration for use in adult airway management in 2003. Currently, 3 sizes are approved for use (3, 4, and 5) and are based on patient height (Fig. 1). The device is comparable with the Combi-Tube (Tyco Healthcare Nellcor, Pleasanton, CA) in principle but is less technically difficult to use and determine correct placement. The Combi-Tube is documented to have low success rates and complications, especially when used infrequently [9]. The LT is blindly inserted, uses 2 cuffed balloons, and is inflated by 1 port (Fig. 2). Several studies have shown that the LT can be used successfully by both hospital and prehospital personnel with variable degrees of experience and is comparable in function to the laryngeal mask airway [10-13].

2. Methods

This was a nonblinded prospective time trial using a cohort of emergency medicine (EM) resident physicians,

fourth year medical students, and paramedic students. Our study was a hypothesis-generating trial with the following aims: (1) evaluate the time to place the LT airway device compared with ETI among varied level providers in simulated patients and (2) evaluate the successful placement of the LT device compared to ETI. The methods and study protocol were approved by the institutional review board.

A total of 36 subjects were enrolled and individually tested using a series of 4 scenarios. The authors were responsible for proctoring and timing each testing session. The scenarios were as follows:

- 1a. trauma, ETI (cervical collar in place, no c-spine manipulation advised)
- 1b. trauma, LTI (cervical collar in place, no c-spine manipulation advised)
- 2a. medical, ETI (no c-spine restrictions)
- 2b. medical, laryngeal tube intubation (LTI) (no c-spine restrictions)

All subjects were tested in the same order (1a-1b-2a-2b). A test room in the Emergency Medical Services Learning Resource Center (EMSLRC) at the University of Iowa was arranged with 2 Laerdal patient simulators (Laerdal Co). The Laerdal AirMan Simulator was used for scenarios 1a and 1b, and the Laerdal SimMan Simulator was used for scenarios 2a and 2b.

For scenarios 1a and 2a, equipment comparable with a standard emergency medical service field airway kit was available. Available equipment included 3.0 and 4.0 Macintosh and Miller blades, a variety of endotracheal tube



Fig. 2 The King laryngeal tube (KING LT-D). Reprinted with permission from King Systems Corp.

Table 1 Demographics

Subject category	With prior anesthesia rotation experience (%)	With prior LT use (%)
EMT-paramedic students (n = 16)	0	0
4th Year medical students (n = 10)	100	0
1st Year EM residents (n = 5)	100	0
2nd Year EM residents (n = 5)	100	0

sizes (6.0-8.0), a gum-elastic bougie, syringes, and stylets. The equipment was opened and placed on a table behind each simulator.

Each subject was brought to the testing room and read aloud a script of instructions. The instructions outlined sequence of testing events, scenario details (eg, trauma vs medical, c-spine precautions, etc), and available equipment. Subjects were instructed to say "finished" or "done" out loud to indicate that their airway management attempt was complete. Before the start of the scenario, subjects were not allowed to inspect the simulators or the available equipment.

Subjects began each scenario at the head of the simulator with their hands at their sides. The time trial began when the proctor said, "Start," and ended when the subject said, "Finished." Each trial was timed with a digital stop watch (Timex IRONMAN Triathlon model no. 62962, Middlebury, CT). At the conclusion of each trial, proctors

confirmed proper device placement by attaching an ambu-bag to the inserted airway and delivering 5 to 6 breaths. Proctors evaluated symmetric chest rise and auscultated the chest and epigastrium for breath sounds. If correct placement was uncertain, tube position was directly visualized using a laryngoscope.

After ETI scenario 1a, subjects were given 30 seconds to review an instructional card provided by the manufacturer (King Systems Corp), outlining proper placement of the LT device. Subjects then completed scenario 1b following the same protocol for scenario 1a, except that LT was added to the equipment kit and subjects used the LT in place of the endotracheal tube (ETT). Confirmation of LT placement was the same as described for ETI. Subjects were not allowed additional time to review the LT instructional card between scenarios 2a and 2b.

For each scenario, both device placement time (seconds) and successful placement were recorded. Following the scenarios, subjects were given a short questionnaire to complete, which was collected before they left the testing room. Subjects were asked to rate the "ease of use" of each of the airway devices. Using a Likert scale (5 = Very Difficult; 4 = Difficult; 3 = Neutral; 2 = Easy; 1 = Very Easy), subjects rated each device in both the trauma and medical scenarios. Participants were also asked about their prior airway management experience, if they had ever taken a formal anesthesia rotation, and if they had any experience using the King LT.

Microsoft Excel 2003 for Windows XP (Microsoft, Redmond, WA) was used for data recording and calculation. The Excel statistical formulas were used to carry out all analyses.

Table 2 Statistics

	AirMan		SimMan	
	Mean placement time (s)		Mean placement time (s)	
<i>All subjects</i>		<i>Successful placement</i>		<i>Successful placement</i>
ETI	76.4 (95% CI, 63.3-89.5)	69.4% (25/36)	45.9 (95% CI, 41.0-50.2)	97.2% (35/36)
LT	26.9 (95% CI, 24.3-29.5)	94.4% (34/36)	20.3 (95% CI, 18.1-22.5)	97.2% (35/36)
	* <i>P</i> < .0001	* <i>P</i> = .006	* <i>P</i> < .0001	–
<i>EMT-paramedic students</i>				
ETI	67.8 (95% CI, 52.6-83.0)	43.8% (7/16)	43.8 (95% CI, 37.7-49.9)	100% (16/16)
LT	23.7 (95% CI, 21.3-26.1)	87.5% (14/16)	18.0 (95% CI, 16.1-19.9)	93.8% (15/16)
	* <i>P</i> < .0001	* <i>P</i> = .025	* <i>P</i> < .0001	<i>P</i> = .309
<i>4th Year medical students</i>				
ETI	74.6 (95% CI, 56.5-92.7)	80% (8/10)	46.7 (95% CI, 38.9-54.5)	90% (9/10)
LT	29.7 (95% CI, 23.1-36.3)	90% (9/10) ^a	19.2 (95% CI, 16.0-22.4)	100% (10/10)
	* <i>P</i> = .003	<i>P</i> = 0.531	* <i>P</i> < .0001	<i>P</i> = .304
<i>All EM residents</i>				
ETI	91.9 (95% CI, 56.0-127.9)	100% (10/10)	47.3 (95% CI, 35.8-58.8)	100% (10/10)
LT	29.5 (95% CI, 24.4-34.6)	100% (10/10)	25.0 (95% CI, 18.9-31.1)	100% (10/10)
	* <i>P</i> = .01	–	* <i>P</i> = .001	–

^a One student used the Combi-Tube rather than the King LT.

* Statistically significant *P* values.

3. Results

Thirty-six subjects participated in the time trial: paramedic students ($n = 16$), fourth year medical students ($n = 10$), first year EM resident physicians ($n = 5$), and second year EM resident physicians ($n = 5$). None of the 36 participants had experience using the King LT. All fourth year medical students (10/10) and EM residents (10/10) had completed a formal training rotation in anesthesia in accordance to their respective curricula. None of the paramedic students (0/16) had completed a formal anesthesia rotation (Table 1).

The mean ETT placement time for all subjects was 76.4 seconds (95% confidence interval [CI], 63.3-89.5) for trauma scenario 1a and 45.9 seconds (95% CI, 41.0-50.2) for medical scenario 2a. Mean LT placement time for all subjects was 26.9 seconds (95% CI, 24.3-29.5) for trauma scenario 1b and 20.3 seconds (95% CI, 18.1-22.5) for medical scenario 2b. The device placement time difference between ETI and LT for both simulators was significant ($P < .0001$).

Successful placement of the LT vs ETT was significant ($P = .001$) using χ^2 analysis in the trauma scenarios (1a and 1b) only (Table 2).

We completed a subgroup analysis (Table 2) based on the subject's current level of training. For trauma scenario 1a and medical scenario 2a, the mean paramedic student placement time for ETI was 67.8 (95% CI, 52.6-83.0) and 43.8 (95% CI, 37.7-49.9) seconds, respectively. Mean paramedic student LT placement time for trauma scenario 1b was 23.7 (95% CI, 21.3-26.1) and 18.0 (95% CI, 16.1-19.9) seconds for medical scenario 2b. Placement time for the LT vs ETI was significant for each scenario subset ($P < .0001$). Paramedic students were successful with ETI 43.8% (7/16) in trauma scenario 1a and 100% (16/16) in medical scenario 2a.

Medical student performance was comparable with the paramedic group with an ETI mean time of 74.6 seconds (95% CI, 56.5-92.7) (scenario 1a) and 46.7 seconds (95% CI, 38.9-54.5) (scenario 2a). Medical student LT placement mean time was 29.7 (95% CI, 23.1-36.3) and 19.2 (95% CI, 16.0-22.4) seconds for scenarios 2a and 2b, respectively. The time difference between ETI and LT showed statistical significance in the trauma scenarios ($P = .003$) and in the medical scenarios ($P < .0001$) (Table 2).

Emergency medicine resident performance showed a mean time of ETI placement to be 91.9 (95% CI, 56.0-127.9) and 47.3 (95% CI, 35.8-58.8) seconds, respectively. Mean LT placement time for EM residents was 29.5 (95% CI, 24.4-34.6) and 25.0 (95% CI, 18.9-31.1) seconds.

Post examination surveys queried the "ease of use" of the LT and ETI in each scenario. A Likert scale (0 = Very Easy, 3 = Neutral, 5 = Very Difficult) was created for the survey instrument, and the reported overall mean level of difficulty in placing the ETT in the trauma scenario (1a) and the medical scenario (2a) was 3.4 and 1.9, respectively. Placement of the LT was given an overall mean level of

difficulty of 1.3 for both scenarios. When asked to compare placing the LT to ETT, subjects reported a mean score of 1.6. Endotracheal intubation was considered more difficult by subjects compared to LT with a score of 3.4.

4. Discussion

This hypothesis-generating trial is limited by several factors. This is a small ($n = 36$) cohort convenience sample of available EM residents, medical students, and paramedic students. The examiners were not blinded to the device being placed nor was there a washout period to allow for a crossover. The successful placement of the LT device may have been misinterpreted by the examiners in the simulated model. Examiners were charged with determining the successful placement of each device. One limitation of the King LT is that it may be positioned too deep in the esophagus and not allow for adequate ventilation. Recognition of deep esophageal placement will prompt subtle repositioning with an improvement in breath sounds. The "misses" in the LT groups (Table 2), we feel, are attributed to examiner, not subject placement, error. No tracheal intubations occurred with the LT.

However, there was significance established: all subjects, despite level of current practice and education, were able to improve placement times with use of the King LT device. In the case of the paramedic students, they significantly improved successful placement of the LT device compared to ETT. Subjects also indicated that the LT was easier to place than ETT in both scenarios. We feel this finding carries weight because none of the subjects had used the LT prior to this trial and were provided with minimal instruction as to its use.

We questioned why the EM resident mean time was higher compared to the other 2 groups. Data analysis revealed 1 resident had difficulty with a time of 199.1 seconds (3.3 minutes) in the trauma scenario. It appeared, as a product of their training, that the residents were more methodical in their approach to the scenario (preparing backup devices and checking equipment functionality), hence using more time.

The King LT is functionally and physically similar to the Combi-Tube but is anatomically different by having only 1 inflation port rather than 2 (Fig. 2).

The American Heart Association Guidelines for cardiac arrest call for focused efforts on quality cardiopulmonary resuscitation and less time off the chest. The authors feel that using an airway device that reduces field intubation time with similar performance to ETI will improve patient care [13].

5. Conclusions

Overall, we feel the LT is a simple and timely device that should be given consideration for use as a bridge device or primary airway adjunct in the prehospital arena. Clearly, a

larger-scale, randomized controlled trial comparing the LT with other means of prehospital and ED airway management is necessary before broad acceptance. With minimal training, patient care providers can expeditiously place the device without using RSI. The LT allows for swift airway management in the most challenging of cases. If used as a bridge device, the LT will allow passage of a gum-elastic bougie or fiberoptic scope to place an ETT [14]. We hope this hypothesis generating trial promotes further evaluation of the LT and the means to enhance or change future prehospital airway management.

Appendix A. Survey instrument

Please circle

How would you rate the EASE of placing the King LT in the "Air Man" simulator?

1. Very Easy
2. Easy
3. Neutral
4. Difficult
5. Very Difficult

How would you rate the EASE of placing the King LT in the "Sim Man" simulator?

1. Very Easy
2. Easy
3. Neutral
4. Difficult
5. Very Difficult

How would you rate the EASE of placing the endotracheal tube in the "Air Man" simulator?

1. Very Easy
2. Easy
3. Neutral
4. Difficult
5. Very Difficult

How would you rate the EASE of placing the endotracheal tube in the "Sim Man" simulator?

1. Very Easy
2. Easy
3. Neutral
4. Difficult
5. Very Difficult

How would you compare the EASE of placing the King LT vs the endotracheal tube overall?

1. Very Easy
2. Easy
3. Neutral

4. Difficult
5. Very Difficult

How would you compare the EASE of placing the endotracheal tube vs the King LT overall?

1. Very Easy
2. Easy
3. Neutral
4. Difficult
5. Very Difficult

Have you done an Anesthesia Rotation in the past 12 months? Yes No

Have you placed the King LT in a patient in the past 12 months? Yes No

If you needed to use the King LT in the ED or other setting, how comfortable would you feel?

1. Very Comfortable
2. Comfortable
3. Neutral
4. Uncomfortable
5. Very Uncomfortable

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