

Use of the King LT for Emergency Airway Management

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Objective: To discuss the role of the King LT reusable supraglottic airway in emergency airway management.

Design: Retrospective case series review.

Setting: Tertiary academic medical facility.

Patients: We studied patients who presented to the emergency trauma center having undergone intubation at an outside facility or at the scene of the incident. The otolaryngology service was consulted for definitive management of the airway.

Main Outcome Measure: Airway evaluation and management once the King LT has been placed.

Results: Six patients with known prehospitalization use of the King LT presented to the emergency trauma center and subsequently required emergency tracheostomy for establishment of a secure airway. Fiberoptic and/or direct

laryngoscopic evaluation performed with the tube in place failed to reveal whether safe oral endotracheal intubation could be performed because of visualization problems. Examination after tracheostomy and removal of the King LT revealed that in 2 patients, orotracheal intubation would have been difficult or impossible, whereas another 4 patients could have been intubated. One patient had prehospitalization placement of a King LT, which resulted in subcutaneous emphysema because of placement within the mediastinum. The patient was able to be successfully intubated and did not require tracheostomy.

Conclusions: The King LT offers benefits in emergency situations, but evaluation of the airway is challenging and often necessitates tracheostomy for establishment of a safe and secure airway. Even if tracheostomy is not required, serious complications may occur.

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A SECURE AIRWAY MUST BE ESTABLISHED for successful cardiopulmonary resuscitation in an emergency.^{1,2} Endotracheal intubation in the field may not be feasible, depending on patient condition and paramedic training.^{3,4} Paramedics may be prohibited from performing intubation by state law, or they may have limited experience with the procedure.^{2,5} These conditions necessitate securing the airway by another method. Available airway devices include the laryngeal mask airway, esophageal obturator airway, esophageal gastric tube airway, Combitube blind insertion airway device (Tyco-Kendall, Mansfield, Massachusetts), and King LT reusable supraglottic airway (King Systems, Noblesville, Indiana).^{3,6} These devices allow for temporary airway management and transport to a medical facility where a multidisciplinary team comprised of emergency medicine physicians, trauma surgeons, anesthesiologists, and otolaryngologists can then establish a definitive airway.

In this series, approved after review by the institutional review board, we describe 6 patients in whom airway management in the field required the placement of a King LT. This device allowed for safe transport of patients to the hospital. How-

ever, after placement of the device in 5 of the patients, adequate evaluation of the airway by the members of the emergency team could not be performed, and emergent tracheostomy was required. In 1 patient, after placement and subsequent removal of the King LT, the patient was able to be intubated, and tracheostomy was not required. We discuss the benefits of the King LT in emergency airway management, the difficulties of airway management once it has been placed, and the role of the otolaryngologist in managing these airway emergencies.

REPORT OF CASES

CASE 1

A 66-year-old man presented to an outside hospital with dyspnea and tongue swelling, with concern for possible angioedema. Multiple attempts at direct laryngoscopy with endotracheal intubation were unsuccessful, and a King LT was subsequently placed. On transfer to the University of Iowa Hospitals and Clinics, the patient was evaluated in the emergency trauma center (ETC) by emergency medicine physicians, anesthesiologists, and otolaryngologists. Evaluation of the patient in the ETC showed a large, protuberant

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tongue. The oral cavity and oropharynx were completely occluded by soft tissue and the pharyngeal balloon of the King LT. Adequate evaluation of the airway was not possible by direct laryngoscopy with a Macintosh laryngoscope. Examination by flexible fiberoptic endoscopy demonstrated soft tissue prolapsing around the tube and lack of any identifiable laryngeal structures. It was unknown whether endotracheal intubation would have been possible after removal of the tube; therefore, an emergency tracheostomy was performed. Evaluation of the airway using an intubating laryngoscope after tracheostomy demonstrated diffuse edema, which would have precluded oral endotracheal intubation.

CASE 2

A 61-year-old man presented to an outside hospital after acute onset of right-sided hemiplegia, right facial droop, and dysarthria. Head computed tomography revealed findings consistent with stroke, and tissue plasminogen activator infusion was initiated. Before transport, the patient had shown signs of decreased consciousness. Direct laryngoscopy was attempted but was unsuccessful, and a King LT was placed. On arrival to the ETC, the patient was once again evaluated by the multidisciplinary airway team. Examination demonstrated that the patient's tongue was swollen and protuberant, extending outside the dental arch. Again, it was unknown whether this feature was secondary to severe angioedema or to soft tissue displacement by the cuff on the King LT. Flexible fiberoptic endoscopic evaluation of the airway revealed poor visualization secondary to soft tissue prolapse, secretions, and the presence of the King LT cuff. Partial deflation of the cuff did not improve visualization, so the patient underwent emergent tracheostomy. Direct laryngoscopy after placement of the tracheostomy tube and removal of the King LT demonstrated severe edema of the tongue, oral cavity, and oropharynx, obscuring visualization of the vocal cords and arytenoids, rendering oral endotracheal intubation impossible.

CASE 3

A morbidly obese 49-year-old man presented to an outside hospital with first-degree flash burns to his face, neck, and right arm. He experienced respiratory distress. Multiple attempts at intubation were unsuccessful, and a King LT was placed. Inhalation injury was suspected but not demonstrated on laryngoscopy. The patient was transported to University of Iowa Hospitals and Clinics, where examination did not demonstrate upper airway burns. Direct laryngoscopy was attempted by the anesthesia team, but because of edema and soft tissue collapse, orotracheal intubation was not possible. An emergency tracheostomy was performed. Subsequent examination of the larynx after tracheostomy did not demonstrate significant airway edema, and endotracheal intubation would have been possible.

CASE 4

A 57-year-old woman presented to University of Iowa Hospitals and Clinics after respiratory distress at home after a

fall. During transport the patient became bradycardic. Orotracheal intubation was attempted, but because of difficulty, a King LT was placed. On arrival at the ETC, multiple attempts to exchange the tube for an endotracheal tube by direct laryngoscopy were unsuccessful because of soft tissue prolapse, edema, and obstruction. These complications were present even after deflating the balloon. The decision was made to secure the airway by way of a tracheostomy. After removal of the King LT, the soft tissue changes quickly resolved. Direct examination of the airway after tracheostomy revealed that oral endotracheal intubation would have been possible.

CASE 5

An 83-year-old man presented to an outside hospital after a fall with loss of consciousness. Paramedics placed a King LT to help secure the airway. En route, after placement of the tube, paramedics noted swelling of the anterior aspect of the neck and chest, which progressed to edema of the tongue and face. Examination at the local ETC revealed upper extremity, neck, and chest swelling, believed to be a result of superior vena cava syndrome. Chest x-ray examination at the outside hospital revealed placement of the tube within the mediastinum and lateral to the thyroid cartilage. Chest computed tomography demonstrated extensive subcutaneous emphysema and a small right-sided pneumothorax, requiring placement of a chest tube. The tube was replaced with an 8.0 endotracheal tube before transfer, at which time the tongue was noted to be markedly swollen. On arrival at our facility, the patient's airway remained secured, and no tracheostomy was required.

CASE 6

A 53-year-old man presented to an outside emergency department with a multiday history of neck pain and odynophagia with mild dyspnea. Computed tomography of the neck revealed some edema and phlegmon. The patient developed worsening dyspnea, and after direct laryngoscopy with multiple failed attempts at oral endotracheal intubation, his airway was secured with a King LT. During placement of the King LT, the patient experienced a posterior pharyngeal laceration. Otolaryngology evaluation with laryngoscopy on transfer to University of Iowa Hospitals and Clinics demonstrated that the airway could not be adequately evaluated, and a tracheostomy was performed. Direct laryngoscopy after the procedure showed an anteriorly placed larynx with the arytenoids visible and some soft tissue swelling. Characteristics for these 6 patients are summarized in the **Table**.

COMMENT

The Combitube, introduced in 1987, is a dual-lumen airway device with 2 inflatable balloon cuffs⁷ (**Figure 1**). It is designed so that a blind insertion can be performed.^{1,2,8} If inserted into the esophagus, as occurs in most cases, the proximal and distal balloons will occlude the oropharynx and esophagus. Ports between the balloons allow for ventilation. If inserted into the trachea, the distal balloon

will occlude the trachea outside the lumen of the tube, and the tube will function similar to an endotracheal tube.⁹

Approved for use in 2003, the King LT is an airway rescue device similar to the blind insertion airway device (Combitube), with proximal and distal balloon cuffs designed to occlude the oropharynx and esophagus (**Figure 2**). The balloons on the King LT are inflated simultaneously, whereas in the Combitube they are inflated sequentially. Unlike the Combitube, the design of the King LT precludes tracheal insertion.² If it were placed in the trachea, ventilation would be prevented by the closed distal end of the tube. The King LT also has only 1 ventilation port, unlike the Combitube, which has 2 ports, requiring the user to select which port to use.² This device also has the advantage of requiring a smaller mouth opening for placement compared with the original Combitube.¹⁰

Numerous studies have examined use of the Combitube and King LT for emergency airway protection. A study¹¹ has demonstrated insertion times of 23.5 seconds for the Combitube and 10 seconds for the King LT on the first attempt. Another study, by Russi et al,² compared placement of the King LT and standard endotracheal intubation in a group of professional paramedics and professional firefighters. The time required for King LT insertion (25.5 seconds) was half the time needed for Combitube insertion (54 seconds) and a third of the time required for the endotracheal tube (91.3 seconds). In the same study, the King LT was successfully placed in 100% of patients compared with 84.1% of patients with the Combitube and 68.9% of patients with an endotracheal tube.

Tongue edema, vocal cord injury, tracheal injury, subcutaneous emphysema, and massive glossal engorgement after use of the Combitube during a period of hours have all been reported complications.^{7,12} Reports¹² of complication rates for the Combitube range from 20% to 40%. Cuff pressures exceeding capillary pressure could potentially cause upper airway edema. Previous reports⁷ have estimated that Combitube pharyngeal cuff inflation to 30 cm H₂O could be 3 times greater than the mucosal perfusion pressure. Specific data for the King LT are not available.

The first 4 patients presented with significant oral and pharyngeal edema. The patient who experienced a stroke was treated with tissue plasminogen activator, an agent known to be associated with causing angioedema. Another patient presented with apparent angioedema of unknown origin, although it is possible that edema was caused from the tube itself. A third presented with edema after first-degree facial burns, without any evidence of inhalation injury. It is unknown whether this patient had edema before King LT insertion because direct laryngoscopy immediately after the tracheostomy failed to demonstrate evidence of inhalation injury or clear reason for difficulty with endotracheal intubation. The fourth patient had no known cause for her soft tissue swelling aside from the King LT itself. At the time of airway evaluation, it was unknown whether the edema would resolve from deflation of the cuff and removal of the tube. This seems to be confirmed by significant resolution of her edema after removal of the tube, resulting in an airway that would have been amenable to endotracheal intubation. The fifth patient had subcutaneous emphysema localized to the upper extremities, chest, and neck. Although there was reported oropharyn-

Table. Demographics of the Study Patients

Patient No./ Age, y/Sex	Underlying Medical Problem	Ability to Intubate Patient
1/66/M	Dyspnea, tongue swelling	No
2/61/M	Stroke	No
3/49/M	Respiratory distress, burns	Yes
4/57/F	Respiratory distress	Yes
5/83/M	Sick sinus syndrome	Yes
6/53/M	Soft tissue infection, dyspnea	Yes

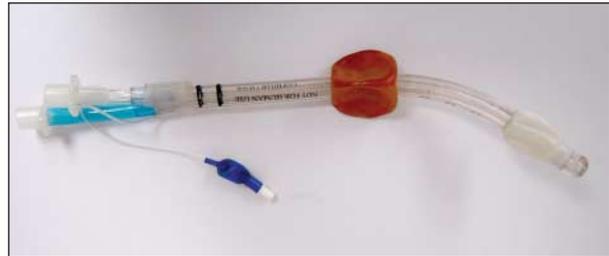


Figure 1. The Combitube, a dual-lumen airway device with 2 inflatable balloon cuffs. During blind insertion, the tube can be placed in the esophagus or trachea. The cuffs to the tube are inflated sequentially to occlude the oropharynx and esophagus (esophageal insertion) or the trachea (tracheal insertion). Ventilation can then occur through the lumen below the inferior balloon during tracheal insertion. If placed within the esophagus, the side ports allow for ventilation into the pharynx with occlusion of the esophagus by the lower balloon.

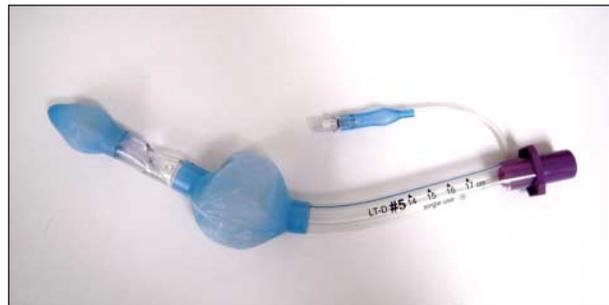


Figure 2. The King LT, a newer alternative to the Combitube. There are proximal and distal balloons that when inflated simultaneously allow for occlusion of the oropharynx and esophagus. Ventilation occurs through the side ports. Unlike the Combitube, this device cannot be inserted into the trachea.

geal edema present after placement of the King LT, it was not significant enough to prevent adequate airway evaluation and endotracheal intubation after removal of the King LT. Had the patient received further ventilatory support while the King LT was in place, progression of the emphysema may have precluded the possibility of intubation, and tracheostomy may have been required. This injury was similar to, but more extensive than, that experienced by the sixth patient.

The design, intended use, and cuff sizes of the Combitube and King LT create the high likelihood of anatomical distortion after tube placement. The Combitube has 100-mL and 15-mL cuffs, whereas the King LT comes in 3 sizes, with cuffs ranging from 60 to 90 mL and cuff pressures of 60 cm H₂O. The cuff sizes ensure that pharyngeal soft tissue will be displaced. In most of the patients described herein, the tongue was markedly protuberant. In

some patients, the tongue returned to a normal position after removal of the tube. The tongue position before removal of the King LT most likely resulted from inflation of the large proximal pharyngeal cuff.

The propensity for pharyngeal edema and anatomical distortion most likely contributed to the difficulty exchanging the King LT airway device for an endotracheal tube. In 4 patients described herein, direct laryngoscopy was not possible given the obscured view from the cuff, soft tissue prolapse, and edema. The only patient in whom successful exchange to an endotracheal tube occurred did not have significant oropharyngeal edema. However, in that patient, the tube and hence the cuff were malpositioned in the mediastinum.

Some authors¹ have been successful in placing an endotracheal tube after deflating the cuff of the Combitube. One method for achieving this goal is to deflate the oropharyngeal balloon, insert the endotracheal tube with visualization assistance by a laryngoscope, then deflate the distal cuff of the Combitube and remove it. Alternatively, the oropharyngeal balloon can be deflated, then a bronchoscope can be passed around the balloon while the patient is continuously provided ventilatory support through the pharyngeal lumen.¹ However, because of limited space in the oropharynx, endotracheal tube placement may be difficult and a surgical airway may be necessary.¹ All the cases presented by Agro et al¹ involved patients who had Combitubes placed in a controlled setting, such as the operating department. None examined the difficulty of securing an airway by endotracheal intubation after insertion of a King LT by paramedics in an emergency situation.

In the patients described herein, the preintubation status of the airway, the cause of the edema, and the true orientation of the soft tissue were all unknown. Deflating the cuffs could have resulted in unsecured airways. The multidisciplinary airway team was unable to determine whether oral endotracheal intubation would have been possible after deflating the cuffs or removing the King LT. Flexible fiberoptic examination was attempted but unsuccessful.

Replacement of the King LT and Combitubes with endotracheal tubes using an exchange tube is also difficult. According to the manufacturer, the King LT-D and King LT(S)-D are designed so that a tube exchange catheter or a fiberoptic bronchoscope may be passed through the tube.¹ The King LT is not designed so that an endotracheal tube may be passed directly.¹³ One study¹³ examined the ability to insert a bougie into the glottic opening, which would then theoretically allow the King LT to be removed and an endotracheal tube advanced. The authors were unsuccessful with this method, primarily meeting resistance from the balloon in the esophagus or the aryepiglottic folds.¹³ In another study,¹⁴ the King LT was successfully exchanged for an endotracheal tube using a fiberoptic bronchoscope. The correct placement of the endotracheal tube required manipulation of the tube to obtain adequate visualization of the glottic aperture.¹⁴ However, unlike the emergency situations presented herein, the aforementioned study was performed on patients who were undergoing scheduled elective surgery and had normal airways with no difficulties noted.

In conclusion, the King LT allows emergency personnel to secure a difficult airway in the field. The many benefits of an airway rescue device such as this are obvious. However, it has been our experience that after placement of these devices, the ability to evaluate the airway is limited. Tracheostomy may be required. These cases demonstrate the value of the King LT in securing a temporary airway in emergency situations and highlight the evaluation and management challenges after placement of such airways.

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