Fibreoptic tracheal intubation after placement of the laryngeal tube†

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Background. The laryngeal tube is a new alternative for securing the airway. After adequate oxygenation, insertion of a tracheal tube is still required in many situations. In such circumstances, fibreoptic placement of a tube exchange catheter after placement of the laryngeal tube is possible before tracheal intubation. Throughout the procedure, oxygen administration can continue via the laryngeal tube, the tube exchange catheter and the tracheal tube.

Methods. The feasibility of this technique was tested in 10 patients scheduled for elective surgery.

Results. The laryngeal tube was placed at the first attempt with adequate ventilation in all patients. The tube exchange manoeuvre was performed successfully in all but one patient.

Conclusion. This technique is an important alternative for airway management and provides a significant degree of patient safety.

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Establishing a patent airway is the primary aim during general anaesthesia as well as in emergency situations. While tracheal intubation is considered the gold standard, it requires adequate skill to secure the airway. The reported incidence of difficult intubation ranges from 0.05 to 18%.1

The American Society of Anesthesiologists Task Force on Management of the Difficult Airway points to the importance of alternative, less invasive devices to allow adequate oxygenation when tracheal intubation fails.2 A new alternative is the laryngeal tube (VBM Medizintechnik, Sulz am Neckar, Germany), which was introduced to the European market in 1999.3 First reports of successful use of the laryngeal tube in out-of-hospital emergency airway management suggest that this device might provide a feasible alternative to tracheal intubation.4 5 The laryngeal tube is a single-lumen tube with an oesophageal and a pharyngeal cuff that are connected to a single inflation line with a ventral opening for ventilation between the two cuffs (Fig. 1).6 After blind insertion, the device provides a patent airway in the majority of patients at the first attempt.7 8 The laryngeal tube can be inserted quickly without extensive training and is considered a simple tool for airway management.9 The oesophageal cuff of the laryngeal tube also allows a good airway seal,7 which was found to be significantly better than that of the standard laryngeal mask airway.10 In emergency situations and in some elective procedures (e.g. positioning in the prone position), tracheal intubation would still be required to protect the patient from aspiration.11 12

Oxygenation of the patient can be achieved by inserting a laryngeal tube, but when replacement by a tracheal tube is necessary, maximum patient safety must be sought. This can be achieved when oxygen can be provided throughout the tube exchange process. The object of this study was to assess the efficacy of a technique using a tube exchange catheter, which has been described for other devices13 14 but not for the laryngeal tube. The laryngeal tube might be considered a dedicated airway; it is defined as "an upper airway device dedicated to the maintenance of airway

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patency while other major airway interventions are anticipated or in progress. 15

Methods

Approval by the local research ethics committee was obtained. Adult patients scheduled for elective orthopaedic surgery and requiring tracheal intubation were asked to participate in this prospective study. All patients were ASA grade I or II; patients with severe pulmonary disease were not included. Patients were older than 18 yr; pregnancy and inability to give consent led to exclusion from the study. None of the patients had a history of airway difficulties during previous anaesthetics or showed signs of anatomical abnormalities; all were Mallampati 1 or 2.16 Ten consecutive patients were recruited and gave written, informed consent. One anaesthetist with 4 yr of experience and special training in fibreoptic intubation performed all the manoeuvres after practising each step on a manikin during five training sessions.

Routine monitoring with electrocardiography, an automatic blood pressure cuff and a pulse oximeter was established before induction of general anaesthesia. Heart rate, blood pressure and oxygen saturation were recorded at all times. A drop in oxygen saturation below 95% at any point led to termination of the procedure, as did more than two attempts at the technique to be tested. Mask ventilation and tracheal intubation performed all the manoeuvres after practising each step on a manikin during five training sessions.

General anaesthesia was induced with fentanyl 1.0–1.5 μg kg−1 and 1% propofol 2–3 mg kg−1 after preoxygenation with oxygen 4 litres via face mask for 1 min. Initially, the patient’s lungs were ventilated with a face mask-bag device. A size 4 or size 5 laryngeal tube was chosen according to the manufacturer’s recommendations, and inserted blindly into the oropharynx without the use of neuromuscular blocking drugs, as demonstrated previously.8 17 18 Both cuffs of the laryngeal tube were deflated completely, and the patient’s head was placed in the neutral position. The tip of the laryngeal tube was introduced along the hard palate with one hand and was guided by the index finger of the opposite hand down the centre of the mouth. Insertion was continued until distinct resistance was felt and the printed ring marks on the tube were aligned with the front teeth. The cuffs were then inflated with 100 ml air using a syringe, and the tube was attached to the breathing system. Cuff pressure was recorded using a cuff pressure gauge. The manufacturer recommends a cuff pressure of 60–80 cm H2O. Time for tube insertion was measured from removal of the face mask to finally positioning the laryngeal tube, and time for securing the airway was measured from inflation of the two cuffs to connecting the breathing system to the laryngeal tube. Adequate airway control was confirmed by auscultation over both lungs and the stomach. Additional verification of the correct position was confirmed by capnometry and bilateral chest expansion. When adequate ventilation had been achieved through the laryngeal tube, rocuronium 0.6 mg kg−1 was given for muscle relaxation.

After ventilation through the laryngeal tube for 1 min, the breathing system was disconnected and a flexible fibreoptic bronchoscope [model FL 10BS (Pentax, Hamburg, Germany), outer diameter 3.4 mm] with a mounted tube exchanger [Aintree Intubation Catheter (Cook Deutschland, Moenchengladbach, Germany), length 560 mm, inner diameter 4.8 mm, with a 15 mm Rapi-Fit™ Adapter (Cook Deutschland, Moenchengladbach, Germany), for use with tracheal tubes whose inner diameter is 7 mm or larger] was inserted through the laryngeal tube. The fibreoptic device was pushed forward until the larynx could be visualized. The exact position of the laryngeal tube in relation to the glottic structures was registered. Therefore the fibreoptic scoring system introduced by Brimacombe and Berry for the laryngeal mask airway19 was used.

The glottis was then entered and the bronchoscope with the tube exchange catheter was advanced into the trachea.
Fig 2 Flexible fibreoptic bronchoscope with mounted tube exchange catheter inserted in the laryngeal tube.

(Fig. 2). The flexible fibreoptic bronchoscope was removed. Both cuffs of the laryngeal tube were deflated completely and the device was removed carefully. The tube exchanger was left in place to railroad a tracheal tube [Lo-Contour™ (Murphy, Mallinckrodt Critical Care Inc., St Louis, MO, USA), inner diameter 7.5 mm] over it. When the tracheal tube was considered to be positioned in the trachea, the tube exchange catheter was removed.

After correct positioning of the tracheal tube had been verified fibreoptically and clinically, the breathing system was attached. Adequate ventilation was assessed by auscultation over the lungs and the stomach and by end-tidal capnometry. Time was measured from disconnecting the laryngeal tube from the breathing system to first ventilation through the tracheal tube.

Any difficulties during the procedure or after the operation, such as hoarseness, sore throat, dysphagia, bleeding and trauma, were recorded. Patients were assessed in the recovery area directly after transfer from the operating theatre, 6 h after the end of anaesthesia, and on the following day.

Results

Three female and seven male patients were included in the study. The mean (range) age of the 10 patients was 63.6 (46–81) yr, the mean (SD) weight was 72.1 (11.2) kg, and the mean (SD) height was 171.9 (7.0) cm.

The laryngeal tube was positioned without any difficulty at the first attempt and adequate ventilation and oxygenation was achieved in all patients. The mean (SD) time for positioning the laryngeal tube was 18.8 (3.4) s. Insertion time for the laryngeal tube was 10.4 (4.3) s, and 8.4 (2.5) s was needed to inflate the cuffs and secure the airway. A size 4 laryngeal tube was used twice, and a size 5 device eight times. All laryngeal tube cuffs were inflated with 100 ml air, resulting in a median cuff pressure of 80.5 cm H₂O (range 68–105 cm H₂O).

The fibreoptic view through the laryngeal tube was optimal in four cases, described as a grade 4 position in the classification by Brimacombe and Berry. In two cases, an aryepiglottic fold and only parts of the vocal cords were seen initially. In another two cases only the aryepiglottic folds were visualized. Careful rotation of the laryngeal tube by approximately 40–60° (three times to the right and once to the left) improved the view in all four cases, resulting in a grade 4 position. In one case, the cords and the posterior epiglottis were seen (a grade 3 position). A jaw thrust manoeuvre allowed an optimal view of the glottic aperture, again resulting in a grade 4 position. In one patient, visualization of the glottis was not possible despite repeated manipulations of the tube (grade 1 position), resulting in failure of the tube exchange manoeuvre. Dislodgement of the laryngeal tube did not occur during any of the manipulations described.

Placement of the tracheal tube was achieved easily in eight patients. In three of these patients, slight rotation of the laryngeal tube was necessary to allow passage of the flexible fibreoptic bronchoscope into the trachea. Displacement of the tube exchange catheter occurred in one case, leading to oesophageal intubation, which was detected immediately. The tube exchange manoeuvre was performed successfully at the second attempt. When insertion of the tracheal tube over the tube exchange catheter was difficult, rotating the tube as recommended for standard fibreoptic intubation facilitated advancement into the trachea; no extensive manipulation of the jaw, as described for other devices, was necessary in those patients in whom the manoeuvre was carried out successfully. The mean (SD) time for positioning the tracheal tube over the tube exchange catheter was 134.0 (36.2) s. The time for each intubation manoeuvre is given in Table 1; no improvement was detected with increasing experience.
No decline in oxygen saturation below 97% was recorded in any of the patients. No cardiovascular irregularities, such as tachycardia (heart rate greater 120 beats \( \text{min}^{-1} \)), bradycardia (heart rate under 50 beats \( \text{min}^{-1} \)), arrhythmias, hypotension or hypertension (blood pressure below 100/60 mm Hg or above 180/100 mm Hg), occurred during induction of anaesthesia or the exchange manoeuvres. The mean heart rate, mean oxygen saturation and the mean systolic and diastolic blood pressure during the procedures are given in Figure 3.

During postoperative examination of the patients, no injuries to the patients’ teeth or lips or the mucosa of the mouth and oropharynx could be found. Two patients presented with minor complaints, one of slight hoarseness and a sore throat and one of mild hoarseness; both recovered fully by the day after surgery. In two patients, minimal mucosal lesions at the carina were observed during fibreoptic confirmation of the tracheal tube position. No correlation between difficulty positioning the tracheal tube and postoperative complaints could be detected.

<table>
<thead>
<tr>
<th>Patient</th>
<th>Time for tube exchange manoeuvre (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>132.1</td>
</tr>
<tr>
<td>2</td>
<td>220.6</td>
</tr>
<tr>
<td>3</td>
<td>133.0</td>
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<tr>
<td>5</td>
<td>117.2</td>
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<td>6</td>
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<td>9</td>
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<td>10</td>
<td>137.7</td>
</tr>
<tr>
<td>Mean</td>
<td>134.0</td>
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Table 1 Individual tracheal intubation time, including exchange manoeuvre, for each patient

Discussion

Adverse respiratory events are a common complication in anaesthetized patients, often resulting in brain damage and death.\(^2\) Approximately 600 people die each year worldwide from difficulties with intubation.\(^2\) The incidence of difficult intubation for elective surgery ranges from 0.05 to 18%.\(^1\) These and other results led to the 1993 ASA recommendations for the use of alternative airway adjuncts that allow adequate ventilation and oxygenation of patients.\(^2\)

The laryngeal tube is a suitable airway management device with a high rate of successful insertion.\(^9\)\(^2\) In our study, it was placed successfully at the first attempt in all patients without any ventilatory problems. As placement is considered easy,\(^2\) its acceptance among physicians, nurses and paramedics is high.\(^9\)\(^2\) Ventilation with the laryngeal tube is comparable to that with other devices.\(^8\) Providing a good airway seal, the laryngeal tube has been shown to be efficacious during mechanical ventilation in adult and paediatric patients undergoing elective surgery.\(^7\)\(^2\)\(^4\)\(^\text{a-f}\

We have demonstrated for the first time the use of the laryngeal tube as an adjunct to ventilation and oxygenation and a guide to viewing the larynx and subsequently positioning a tracheal tube. The experience is encouraging, especially because oxygen administration is possible at every stage of the manoeuvre. Difficulty positioning the Aintree catheter occurred in only one patient in our study; in this patient the glottic aperture could not be visualized, yet adequate ventilation was possible at all times through the laryngeal tube. Initial oesophageal intubation in one patient was probably caused by displacement of the tube exchange catheter during railroading of the tracheal tube. Correct tracheal positioning of the Aintree catheter had been confirmed during fibreoptic-guided placement, but removal of the laryngeal tube when the catheter tip lay close to the glottis may have led to dislodgement. This can also occur.

![Fig 3](https://academic.oup.com/bja/article-abstract/89/5/733/249928/249928) Changes in mean heart rate (beats \( \text{min}^{-1} \)), mean oxygen saturation (%) and mean systolic and diastolic arterial blood pressure (mm Hg) at each stage of the tube exchange manoeuvre.
when railroading a tracheal tube over a fiberoptic bronchoscope that is not inserted far enough into the trachea.

A comparable procedure has been described for the laryngeal mask airway and the cuffed oropharyngeal airway (COPA). In general, the concept of the ‘dedicated airway’ will not only help to master difficult intubation but also allow training in fiberoptic intubation, even in patients known to be difficult to intubate under safe conditions. The time needed for inserting the tracheal tube was comparable to that achieved with the COPA. Because of a different protocol, comparison with the insertion times described for the laryngeal mask airway is not possible. In contrast to the latter study, no improvement with practice was observed in our study, probably as a result of prior manikin practice.

An important advantage of the laryngeal tube is its stable positioning even when manipulation is necessary to improve the view of the glottic aperture. Additionally, the specific configuration of the aperture of the laryngeal tube guides the tip of the flexible fiberoptic bronchoscope more towards the glottis than would be the case with the standard laryngeal mask airway.

As the glottic aperture could not be visualized in all patients without manipulation of the laryngeal tube, blind insertion of an exchange bougie without fiberoptic control, as described for other airway devices, cannot be recommended. The fact that the position of the laryngeal mask airway during fiberoptic control was only central in 59% of cases supports the idea of using a fiberoptic bronchoscope rather than inserting a tube exchange catheter blindly through any airway device. Because of the variable position of the blindly inserted laryngeal mask airway with respect to the glottic aperture, use of a fiberoptic bronchoscope also increases the success rate of tracheal intubation via a laryngeal mask.

The manoeuvre described in this study allows a high degree of control of the patient’s airway. Continuous application of oxygen into the trachea is possible via the laryngeal tube and the tube exchange catheter. The oxygen saturation did not fall below 97% and jet ventilation via the Aintree catheter, which is an option when managing difficult airways for a limited period, was not required. Haemodynamic side-effects, as reported with the intubating laryngeal mask airway, did not occur during the tube exchange manoeuvre via the laryngeal tube.

The concept of oxygenation being more important than the intubation is an essential part of recommendations for managing the difficult airway. Because the laryngeal tube might be an important alternative for managing the difficult airway, a technique for subsequently placing a tracheal tube over this device should be considered after initial oxygenation problems have been solved. Thorough planning for airway emergencies should always include procedures that allow administration of oxygen at any time, as this is an important factor in improving patient outcome after critical incidents. Fiberoptic control of the tube position guarantees a maximum degree of patient safety.

Postoperative airway examination showed no severe trauma induced by insertion of the laryngeal tube or the tube exchange catheter. Visible lesions of the upper airway, such as haematoma and mucosal laceration, as described most often for the Combitube, did not occur in any of the patients studied. Mild hoarseness and a slight sore throat are common postoperative complaints after tracheal intubation or the use of a laryngeal mask airway or the Combitube. The incidence of postoperative airway discomfort depends on the airway management device. A sore throat and dysphagia are most common after placement of the Combitube, with an incidence of 48 and 68% respectively. After use of the laryngeal mask airway, patients suffer from dysphagia in 33% of cases. This complaint is significantly less frequent in patients undergoing tracheal intubation. In our study, no case of dysphagia was recorded, although two airway devices were placed. Tracheal intubation is considered the main cause of hoarseness. The incidence ranges from 14.4% to 32%. Although in our study the tracheal tube was inserted over the tube exchange catheter without direct visualization of its passage through the vocal cords, only two of the 10 patients complained of hoarseness. Mucosal lesions on the carina in two of the patients were probably induced by the rigid tip of the tube exchange catheter, which was held in place during removal of the laryngeal tube. This problem might be solved by a catheter with a softer distal tip.

There are limitations of this study. As none of the patients presented with a difficult airway, the feasibility of this technique should also be evaluated under these conditions. Comparison of the performance of physicians at various stages of their training might help in judging the usefulness of the manoeuvre described here.

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