Effects of using two airway exchange catheters on laryngeal passage during change from a double-lumen tracheal tube to a single-lumen tracheal tube

A. Suzuki*, M. Uraoka, K. Kimura and S. Sato

Department of Anesthesiology and Intensive Care, Hamamatsu University School of Medicine, 1-20-1 Handayama, Hamamatsu, Shizuoka 431-3192, Japan
*Corresponding author. E-mail: akiras@hama-med.ac.jp

Background. A thin airway exchange catheter (AEC) is often used for changing from a double-lumen tracheal tube (DLT) to a single-lumen tracheal tube. However, passage of the tube into the trachea is often difficult. The purpose of this study was to evaluate the effectiveness of using two AECs for tracheal tube exchange.

Methods. In Study 1, 30 patients were randomly allocated to two groups and one AEC was inserted into the trachea in one group, and two AECs in the other group. A tracheal tube was advanced into the pharynx over the AEC(s). A blinded observer assessed the difficulty of passing the tube into the trachea. In Study 2, another group of 30 patients (whose airways had been managed with DLTs) were randomly allocated to two groups, and either one or two AECs were inserted into the DLT depending upon the group allocation. The difficulty of passing the tube into the trachea was assessed and the time required for exchange was measured.

Results. The use of two AECs reduced the incidence of impingement of the tube into the trachea during the AEC-guided tracheal intubation (Study 1) from 93 to 33% (P < 0.05) and during exchange from a DLT to a single-lumen tracheal tube (Study 2) from 100 to 27% (P < 0.05). The exchange time was similar: 106 (7) and 116 (4) s [mean (SD)] for one and two AECs, respectively.

Conclusion. The use of two AECs reduces the incidence of impingement of the tube into the trachea during tracheal tube exchange.

Br J Anaesth 2007; 99: 440–3

Keywords: clinical trials; complications, intubation tracheal; equipment, airway exchange catheter

Accepted for publication: May 23, 2007

Changing from a double-lumen tracheal tube (DLT) to a single-lumen tracheal tube during surgery or at the end of an operation can be a difficult.1 An airway exchange catheter (AEC) is a useful tool for this procedure, but passage of the tracheal tube into the trachea during re-intubation after DLT removal is often difficult over a thin AEC. A taper-tipped tracheal tube (Flex-Tip™; Parker Medical, Englewood, CO, USA) may be useful as an adjunct for oral tracheal tube exchange using a thin AEC, but this tracheal tube is not available in Japan.2 Hence, for changing from a DLT to a single-lumen tracheal tube, we investigated the use of two thin AECs with one AEC inserted into the right lung catheter and the other inserted into the left lung catheter of the DLT. The purpose of this study was to evaluate the effectiveness of this approach for tracheal tube exchange. In Study 1, we simulated the latter (re-intubation) process in tracheal tube exchange by performing AEC-guided tracheal intubation during the induction of anaesthesia for elective surgery. A blinded observer assessed the difficulty of passing the tube into the trachea. Study 2 was performed during the recovery period from anaesthesia with thoracic surgery patients using a DLT. During the tube change from the DLT to a single-lumen tracheal tube, we assessed the difficulty of passing...
the tracheal tube into the trachea. We also measured the time required for tube exchange.

Methods

Study 1

The Institutional Review Board of Hamamatsu University School of Medicine approved the study and all patients gave written consent. Patients, ASA I or II, who underwent anaesthesia and required orotracheal intubation were included in the study. Exclusion criteria were as follows: age < 20 yr, and patients with pulmonary diseases, cervical spine fracture, or known pathology or previous surgery in the mouth, pharynx or larynx. Head and neck movement, and height and weight were evaluated before the operation. The patients were randomly allocated into two groups by computer-generated assignment of numbers. These were one-AEC or two-AEC groups, in which one or two AECs, respectively, were used for tracheal intubation.

A standard anaesthesia protocol was followed. Patients received oxygen 100% for 3 min, and anaesthesia was then induced with fentanyl 2 μg kg\(^{-1}\) and propofol 2 mg kg\(^{-1}\). Muscle paralysis was induced by vecuronium 0.1 mg kg\(^{-1}\) and an assisted ventilation of the lungs was established with oxygen 100% and sevoflurane 3% via a face mask. The adequacy of neuromuscular block was confirmed with a peripheral nerve stimulator. In the one-AEC group, an AEC (2.5 mm OD, C-CAE-11.0-83-DLT; Cook Critical Care, Bloomington, IN, USA) was inserted into the trachea using direct laryngoscopy. In the two-AEC group, an additional AEC was inserted into the trachea after the insertion of the first AEC. A tracheal tube (7.5 mm ID, Profile Soft Seal Cuff Ivory, Portex Limited, Hythe, Kent, UK) was advanced into the pharynx over the AECs, with the bevel face of the tracheal tube oriented to the left. For the one-AEC group, a shortened AEC cut at 20 cm from the tip, thereby making it of insufficient length to reach the trachea, was inserted into the tracheal tube from the proximal end. The proximal ends of the two AECs were bound together by rubber bands in all patients. The tip of the shortened AEC was rounded to avoid airway injuries. In all patients, one anaesthetist (A.S.) inserted the AEC(s) into the trachea, the tracheal tube into the pharynx and the shortened AEC into the tracheal tube. After the laryngoscope was removed, another anaesthetist (M.U.) who was blinded to the study groups was allowed to enter the operating room to perform the investigational part of the study. At this time, the anaesthetist (M.U.) could see the opaque tracheal tube, which was inserted into the oral cavity, and the proximal ends of the two AECs, which were inserted into the tracheal tube in both groups. The anaesthetist (M.U.) gently railroaded the tracheal tube over the AECs (one-AEC group, one normal length AEC and one shortened AEC; two-AEC group, two normal length AECs) into the trachea, and assessed the difficulty of the passage of the tracheal tube into the trachea, using a four-point scale (Table 1). The other anaesthetist (A.S.) performed airway suction to assess airway bleeding.

Study 2

The Institutional Review Board of Hamamatsu University School of Medicine approved this study after they had considered the results in Study 1. Written consent was obtained from each patient. Thirty patients, ASA I or II, who underwent thoracic surgery under general anaesthesia with the use of DLT were included in the study. Exclusion criteria were as follows: age < 20 yr, and patients with cervical spine fracture, or known pathology or previous surgery in the mouth, pharynx or larynx, or in whom intubation was predicted to be difficult. Head and neck movement, and height and weight were evaluated before the operation. The patients were randomly allocated into two groups by computer-generated assignment of numbers: the one-AEC and two-AEC groups, in whom one and two AECs, respectively, were used for tracheal tube exchange from the DLT to a single-lumen tracheal tube.

A standard anaesthesia protocol was followed and routine monitoring was performed. After epidural catheter placement, the patients received oxygen 100% for 3 min and general anaesthesia was induced with fentanyl 2 μg kg\(^{-1}\) and propofol 2 mg kg\(^{-1}\). Muscle paralysis was induced by vecuronium 0.1 mg kg\(^{-1}\). A DLT (Broncho-Cath™ Left size 35 F or 37 F, Mallinckrodt Medical, Athlone, UK) was inserted, and its location was confirmed and the distance from the fore-tooth to the carina was measured using a fibrescope (LF-2, Olympus, Tokyo, Japan). We excluded a patient from the study if tracheal intubation was difficult using a laryngoscope. Anaesthesia was maintained with intermittent fentanyl i.v. and vecuronium, epidural injection of local anaesthetics, and continuous inhalation of sevoflurane.

After the completion of surgery, the ventilation of the lungs was continued with oxygen 100% and sevoflurane 1.5% via a DLT in the supine position. The adequacy of neuromuscular block (train-of-four stimulation, zero-fourth) was confirmed with a peripheral nerve stimulator. Additional vecuronium (0.02–0.04 mg kg\(^{-1}\)) was administered to improve the condition of muscle paralysis, if needed. The head of the patient was maintained in the ‘sniffing position’. In all patients, one anaesthetist (K.K.)

<table>
<thead>
<tr>
<th>Grade</th>
<th>Difficulty</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>No difficulty passing the tracheal tube</td>
</tr>
<tr>
<td>2</td>
<td>Obstruction while passing the tracheal tube, relieved by withdrawal and a 90° anticlockwise rotation</td>
</tr>
<tr>
<td>3</td>
<td>Obstruction necessitating more than one manipulation or external laryngeal manipulation</td>
</tr>
<tr>
<td>4</td>
<td>Direct laryngoscopy required</td>
</tr>
</tbody>
</table>
inserted a laryngoscope into the mouth to keep the tongue to the left. The tip of the laryngoscope blade was kept in the pharynx. This anaesthetist (K.K.) observed the oral cavity to maintain a precise positioning and proper shape of the AEC(s) throughout the study. A stopwatch was started to measure the time required for tube exchange. In the one-AEC group, an AEC (2.5 mm OD, C-CAE-11.0-83-DLT; Cook Critical Care) was advanced into the bronchial lumen of the DLT. In the two-AEC group, one AEC was advanced into the bronchial lumen and another AEC was advanced into the tracheal lumen of the DLT. In both groups, olive oil was applied to the surface of the AEC(s) as a lubricant. The tip of the AEC was located 2 cm above the carina throughout the study to prevent lung injuries. The DLT was removed gently from the trachea while maintaining the position of the AEC(s). In the two-AEC group, the proximal ends of the two AECs were bound together with adhesive tape. A tracheal tube (7.5 mm ID, Profile Soft Seal Cuff Clear, Portex Limited, UK) was railroaded gently into the trachea over the AECs, with the bevel face of the tracheal tube oriented to the left. The difficulty of the passage of the tracheal tube into the trachea was assessed using a four-point scale (Table 1). Assessment was performed by one anaesthetist (A.S.). After the tracheal tube advancement, the AEC(s) were removed and the cuff of the tracheal tube was inflated. Successful intubation was confirmed by the presence of a carbon dioxide waveform on a capnograph. The anaesthetist (A.S.) stopped the stopwatch at the time of the appearance of the carbon dioxide waveform. The anaesthetist (A.S.) also performed bronchoscopy to assess airway injuries after the tracheal tube exchange.

We aimed to detect a reduction in the incidence of glottis impingement of the tracheal tube from 95 to 45%, with reference to the comparison of a thin AEC with a thick AEC in a previous study. A sample size calculation based on an α value of 0.05 and a β value of 0.2 gave an estimated required sample size of 12 patients in each group; 15 patients were actually included in each group to compensate for patients not completing the study. Statistical analysis of the difficulty of the passage of the tracheal tube into the trachea were performed using a Mann–Whitney rank sum test for the comparison of the one-AEC group with the two-AEC group. Other data were compared between groups using a Student’s t-test. Statistical significance was taken as P<0.05. Results are presented as mean (SD). Data were analysed with GraphPad Prism (4.03 for Windows; GraphPad Software, San Diego, CA, USA).

**Results**

A total of 30 patients were initially included in Study 1. Fourteen patients in the one-AEC group and 15 in the two-AEC group completed the study. One patient in the one-AEC group did not complete the study, as we were unable to insert the AEC into the trachea using direct laryngoscopy. An AEC or AEC(s) came out from the trachea during manipulation of the tracheal tube in one patient in each group. A difficulty grade of four was assigned for these two patients. The patients’ characteristics were similar in the two groups (Table 2).

The scores for the difficulty of the passage of the tracheal tube into the trachea are shown in Table 3 (P<0.05, Mann–Whitney rank sum test). In the one-AEC group, one or more manipulations were needed (Grades 2–4) to pass the tracheal tube in 13 patients (93%), whereas this occurred for only five patients (33%) in the two-AEC group. Neither airway bleeding nor hypoxaemia was observed during the study in patients of either group.

In Study 2, a total of 30 patients were enrolled and all completed the study. The patients’ characteristics were similar in the two groups (Table 2). In all cases, it was easy to pass two AECs through a DLT and easy to remove the DLT without dislodging the AEC(s). The scores for the difficulty of the passage of the tracheal tube into the trachea are shown in Table 3 (P<0.05, Mann–Whitney rank sum test). In the one-AEC group, one or more manipulations were needed (Grades 2–4) to pass the tracheal tube in 15 patients (100%), whereas this occurred for four patients (27%) in the two-AEC group. The time required for tracheal tube exchange was 106 (7) s [mean (sd)] in the one-AEC group and 116 (4) s in the two-AEC group (no significant difference between the groups). Neither lung injuries nor hypoxaemia were observed during the study.

<table>
<thead>
<tr>
<th>Grade of difficulty</th>
<th>Study 1*</th>
<th>Study 2*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>One-AEC group</td>
<td>Two-AEC group</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>2</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td>7</td>
<td>1</td>
</tr>
</tbody>
</table>

*P<0.05 for one-AEC group vs two-AEC group.
Discussion

In Study 1, the use of two AECs, when compared with the use of one AEC, led to a 60% reduction in the incidence of glottis impingement of the tracheal tube during exchange-guided tracheal intubation. During the tracheal tube exchange in Study 2, the use of two AECs led to a 73% reduction in the incidence of glottis impingement of the tracheal tube. The incidence of glottis impingement using one AEC was 93% (13/14) in Study 1 and 100% (15/15) in Study 2, results consistent with the incidence (95%) found in a previous study. Several studies have shown that, when compared with a thin AEC or a fibrescope, a thicker guide reduces the incidence of glottis impingement because it is more likely to fill the space within the tracheal tube. In the present study, the use of two AECs significantly reduced the incidence of glottis impingement suggesting that two AECs may have the same effect as the use of a thicker introducer for the tracheal tube.

It has been reported that the right arytenoid cartilage frequently inhibits the advancement of the tracheal tube over the fibrescope into the trachea during the awake fibreoptic orotracheal intubation. With 90° anticlockwise rotation of the tracheal tube, the bevel of the tracheal tube faces posteriorly and the tip of the tracheal tube is positioned anteriorly between the introducer and the anterior commissure. This rotation technique reduces the incidence of glottis impingement of the tracheal tube during gum-elastic bougie-guided tracheal intubation under general anaesthesia, and during fibreoptic orotracheal intubation under general anaesthesia. A 90° anticlockwise rotation of the tracheal tube also reduces the incidence of glottis impingement during AEC-guided tracheal intubation under general anaesthesia. In our study, 90° anticlockwise rotation of a tracheal tube often relieved the impingement. Therefore, the combined use of two AECs and 90° anticlockwise rotation of the tracheal tube may lead to a higher success rate of the passage of the tracheal tube into the trachea.

Dogra and colleagues have demonstrated that the presence of a laryngoscope in the mouth while railroading a tracheal tube over a gum-elastic bougie causes a significant difference in the rate of successful tracheal intubation. The success rate without a laryngoscope was 22% whereas that with a laryngoscope was 74%. The authors suggested that the flexible gum-elastic bougie often curves anteriorly from the posterior pharyngeal wall, and the presence of the laryngoscope allows the bougie to maintain a straighter line and thus facilitate tracheal intubation more effectively. Benumof suggested that the risk of failure to pass a tracheal tube over an AEC can be minimized by the concomitant use of a laryngoscope whenever possible, as optimal laryngoscopy helps to clear the supraglottic pathway that the tracheal tube must take in passage over the AEC. In Study 1, we did not use a laryngoscope initially during the railroading of the tracheal tube into the trachea. Direct laryngoscopy was performed if the following procedures were not effective: 90° anticlockwise rotation of the tracheal tube, and more than one manipulation or external laryngeal manipulation. An AEC or AECs came out from the trachea during the manipulation of the tracheal tube in two patients in Study 1 whereas in Study 2, in which a laryngoscope was used, the AEC or AECs stayed in the proper position in all patients.

An AEC may incidentally be taken out of the trachea during the tracheal tube exchange procedure and that tube exchange may fail. Tracheal tube exchange using two AECs is a more complex procedure than that using one AEC as an additional AEC has to be inserted and the DLT has to be removed without dislodging the two AECs. However, in Study 2, the time needed for the tracheal tube exchange did not differ between the one-AEC and the two-AEC groups and neither lung injuries nor hypoxaemia occurred in either group.

Limitations of the study include that, in Study 1, we did not use a DLT before performing AEC-guided tracheal intubation, whereas in Study 2, the observer was not blinded as to the allocation. Despite these limitations, the results of the two studies are complementary and we conclude that during tracheal tube exchange using an AEC it is important to fill the gap between the leading edge of the tracheal tube and the AEC to reduce the incidence of the impingement of the tracheal tube. Hence, the use of two AECs may give a higher success rate of passage of the tracheal tube into the trachea when compared with the use of one AEC.

References