Effects of tracheal tube orientation on the success of intubation through an intubating laryngeal mask airway: study in Mallampati class 3 or 4 patients

L. Ye1, J. Liu1, D. T. Wong2 and T. Zhu1*

1Department of Anaesthesiology, West China Hospital, Sichuan University, Chengdu Sichuan Province 610041, People’s Republic of China. 2Department of Anaesthesiology, Toronto Western Hospital, University Health Network, University of Toronto, Ontario, Canada M5T 2S8

*Corresponding author. E-mail: xwtao.zhu@gmail.com

Background. We evaluated the effects of conventional tracheal tube orientation on success of intubation through an intubating laryngeal mask airway (ILMA) in Mallampati class 3 or 4 patients.

Methods. Two hundred adults, ASA I–II, Mallampati class 3 or 4, undergoing elective surgery under general anaesthesia were enrolled. All the patients were randomly allocated to either normal or reverse group based on the orientation of the tracheal tube as it was initially inserted into the ILMA. Tracheal intubation was considered successful, if proper tracheal positioning was attained within three insertion attempts. \( \chi^2 \) analysis was used to compare categorical variables.

Results. Tracheal intubation through the ILMA was successful in 183 of 200 patients (91.5%): 157 (78.5%) on the first attempt. Seventeen (8.5%) were intubated using direct laryngoscopy. The first-attempt success rate was higher in the reverse than in the normal group (85.0% vs 72.0%, \( P=0.025 \)), although the overall success rate was similar between the reverse and the normal groups (93.0% vs 90.0%). The incidence of sore throat was comparable in the normal group and the reverse group (22.0% vs 12.0%, NS).

Conclusions. Overall, tracheal intubation was successful in 91.5% of patients through an ILMA with a conventional tracheal tube in Mallampati class 3 or 4 patients. The first-attempt success rate was higher in the reverse group compared with the normal group, but the overall success rate was similar between the reverse and the normal groups.


Keywords: anatomy, airway; complications, intubation tracheal; equipment, laryngeal mask; equipment, tubes tracheal

Accepted for publication: November 4, 2008

The intubating laryngeal mask airway (ILMA, LMA-Fastrach™, LMA North America, Inc., San Diego, CA, USA) has been introduced into clinical practice for more than 10 yr. The reusable, relatively expensive Fastrach™ silicone wire-reinforced tube was designed for tracheal intubation through the ILMA. A polyvinyl chloride conventional tracheal tube is disposable, less expensive, and readily available. However, Brain, the inventor of the ILMA, did not recommend its usage for intubation through an ILMA because of its stiffness and potential difficulties in passage through the glottis. Studies have shown that conventional tracheal tubes can be successfully used for tracheal intubation through the ILMA. It was demonstrated that intubation success is higher, if the tracheal tubes are inserted in a reverse orientation compared with the normal orientation. One limitation of these previous studies is that all patients exhibited normal airways with Mallampati class 1 or 2. The purpose of this study was to evaluate the effects of conventional tracheal tube orientation on success of intubation through an ILMA in Mallampati class 3 or 4 patients.

Methods

The study was approved by the Institutional Research Ethics Board and written consent was obtained from all the patients. Adult patients, ASA I or II, undergoing general anaesthesia and tracheal intubation were examined and a Mallampati class ascertained. Exclusion criteria included morbid obesity, respiratory tract (oropharynx and larynx) pathology, limited mouth opening (inter-incisor gap <2 cm), and risk
of aspiration (previous upper gastrointestinal tract surgery, known or symptomatic hiatus hernia, oesophageal reflux, peptic ulceration, or not fasted). Two hundred consecutive patients with Mallampati class 3 or 4 were enrolled. Patients were randomly assigned by closed envelopes containing computer-generated randomization codes, to one of the two equal-sized groups (n=100 each): normal group or reverse group depending on the orientation of the tracheal tube at the point of insertion into the ILMA. In the normal group, the tracheal tube was inserted with its natural curve following the 90° curvature of ILMA, but in the reverse group, the natural curve of the tracheal tube was directed opposite to the curvature of the ILMA (Fig. 1). 

A size 3 ILMA and a 7.0 mm ID polyvinyl chloride conventional tracheal tube (Mallinckrodt® tracheal tube, Comamaddy Athlone Co., Ireland) were used for patients weighing <50 kg, and a size 4 ILMA and a 7.5 mm ID tracheal tube were used for patients weighing >50 kg. All procedures were performed by a single experienced attending anaesthesiologist.

Standard monitoring, including ECG, pulse oximetry, capnography, and non-invasive blood pressure monitor, was performed and the anaesthetic management was standardized. Patients were pre-oxygenated (FiO₂=1.0) for 3 min and general anaesthesia was induced with propofol 2–3 mg kg⁻¹ and fentanyl 2–3 μg kg⁻¹. After confirmation of face mask ventilation, rocuronium 0.6 mg kg⁻¹ was administered. An ILMA was inserted with the head–neck in the neutral position, and the cuff was inflated with air until an effective seal was achieved or up to the maximum recommended volume (20 ml in size 3 and 30 ml in size 4). Adequate ventilation was assessed by chest wall movement, capnograph waveform, and no oropharyngeal leak with peak airway pressures >20 cm H₂O during manual ventilation. Oropharyngeal leak pressure was taken to be that pressure at which gas could first be heard escaping around the laryngeal mask airway during manually assisted ventilation. If adequate ventilation was not attained, the ILMA was manipulated (up–down and Chandy’s manoeuvres) in situ, and a single change of ILMA size was permitted. Anaesthesia was maintained with volatile anaesthetics in oxygen 100% during the intubation attempts.

After lubrication, the tracheal tube was initially inserted into the ILMA with the orientation according to randomization (Fig. 1). If no resistance was encountered with the passage of the tracheal tube, it was advanced to the full distance (28–29 cm). If resistance was encountered during passage of the tracheal tube, Chandy’s manoeuvre was performed and further advancement attempted. An intubation attempt was considered a failure if (i) the tracheal tube tip could not be advanced the full distance of the tracheal tube, (ii) the tracheal tube was advanced the full distance, but no capnographic tracing was seen, or (iii) the patient’s oxygen saturation was <90% and the intubation attempt was abandoned. An intubation attempt was considered successful, if the tracheal tube advanced to the full distance and a positive capnographic tracing was obtained. After successful tracheal intubation, the ILMA was removed using the standard technique and the stabilizing rod.

In each patient, intubation via the ILMA was limited to three attempts. After each failed intubation attempt, the ILMA was reinserted and ventilation compliance optimized. After three attempts, if intubation was not successful, tracheal intubation was performed under direct laryngoscopy. Fibreoptic bronchoscopy was available for intubation if needed.

The primary outcome measure was the first-attempt intubation success rate between the normal group and the reverse group in Mallampati class 3 or 4 patients. Other outcome measures include cumulative third-attempt intubation success rate between the normal group and the reverse group in Mallampati class 3 or 4 patients. Patients were interviewed the next day after surgery to evaluate for sore throat using a verbal analogue scale (0–10). A verbal analogue scale >3 was considered positive.

On the basis of our pilot study data, the first intubation attempt success of the normal and reverse orientation in Mallampati class 3 or 4 patients was 60% and 80%, respectively. A sample size of 81 allowed the detection of a 20% difference in the proportion of successful intubation.
between normal and reverse orientation in Mallampati class 3 or 4 patients, with an \( \alpha \) of 0.05 (two-tailed) and a \( \beta \) of 0.20, power of 0.8. To account for attrition, a sample size of 100 was selected for each of the normal and reverse groups.

Data were analysed with SPSS Version 13.0 (SPSS Inc., Chicago, IL, USA). t-Test was used for continuous variables and \( \chi^2 \) analysis with the Bonferroni correction was used for categorical variables. \( P<0.05 \) was considered statistically significant.

Results
A total of 2011 patients were screened for study eligibility. Of these, 1754 patients (87.2%) were excluded because they had Mallampati class 1 or 2. Sixteen patients refused to participate in the study and 41 met one or more of the exclusion criteria. Thus, 200 patients were included in the study.

The patient characteristics were similar between the two groups (Table 1). Placement of the ILMA was successful in all patients. The success rates of tracheal intubation through ILMA are illustrated in Table 2. Tracheal intubation was successful in 183 (91.5%) of 200 patients. Successful intubation on the first attempt was achieved in 157 (78.5%) patients. In 17 (8.5%) patients, intubation was accomplished using direct laryngoscopy. The mean (sd) number of intubation attempts was 1.4 (0.7).

The first-attempt success rate was higher in the reverse group than in the normal group (85.0% vs 72.0%, \( P=0.025 \), absolute difference 13%, 95% confidence interval for the difference: 1.8–24.2%). However, the third-attempt cumulative success rate was comparable between the normal and the reverse groups (90.0% vs 93.0%). The number of intubation attempts was higher in the normal group than in the reverse group [1.5 (0.8) vs 1.3 (0.6), \( P=0.004 \)].

Sore throat
The incidence of sore throat was not significantly different between the two groups (22.0% in the normal group and 12.0% in the reverse group). Sore throat was mostly mild and lasted for 2–3 days without requiring medical intervention.

Discussion
Overall, tracheal intubation was successful in 91.5% of patients through an ILMA with a conventional tracheal tube in Mallampati class 3 or 4 patients. The first-attempt success rate was higher in the reverse group compared with the normal group, but the overall success rate was similar between the groups.

Since Brain and colleagues\(^7\) reported a 99.3% success rate in their preliminary clinical trial in 1997, studies have used primarily silicone wire-reinforced tube for tracheal intubation through the ILMA. However, none of the subsequent studies could achieve the same success rate as Brain and colleagues (89–98%).\(^8\)–\(^10\)

Despite certain disadvantages, clinicians continue to use the polyvinyl chloride conventional tracheal tubes because they are less expensive, readily available, and disposable. In 2005, Kundra and colleagues\(^4\) demonstrated a 96% success rate within two intubation attempts with both Rusch polyvinyl chloride tubes in normal orientation and with silicone wire-reinforced tubes. Two other studies reported insertion of conventional tracheal tubes via the ILMA.\(^2\)\(^3\) In 1999, Joo and Rose\(^2\) reported a 96.7% intubation success rate with reverse orientation using polyvinyl chloride tracheal tubes. In 2000, Lu and colleagues\(^3\) reported a 95.4% third-attempt cumulative success rate with the Sheridan tracheal tube in two orientations. Our study demonstrated a third-attempt cumulative intubation success rate of 91.5%. The first-attempt success rate is another important performance indicator for tracheal intubation. Our study demonstrates a success rate of 78.5% on the first attempt compared with 80.8–86.7% in other studies.\(^2\)\(^–\)\(^4\) Our third-attempt cumulative success and first-attempt success rates are comparable with those reported in the literature.\(^2\)\(^–\)\(^4\) Findings from our study and from the literature\(^2\)\(^–\)\(^4\) demonstrate that polyvinyl chloride conventional tracheal tubes may be used for insertion via the ILMA.

Tracheal intubation via an ILMA with the conventional tracheal tube inserted in reverse orientation was first described by Joo and Rose.\(^2\) The present study and the study by Lu and colleagues\(^3\) are the only two randomized clinical trials evaluating the effect of tracheal tube orientation on intubation success with an ILMA. Both studies found that there was no difference in the overall success rates of tracheal intubation between the normal and reverse orientation groups; but, our first-attempt success rate in the reverse group was higher than that in the normal orientation group.

An important factor that determines the success of tracheal intubation is the angle at which the tracheal tube emerges from the distal aperture of the ILMA.\(^1\)\(^4\) Brain and colleagues,\(^1\) and Kundra and colleagues,\(^4\) have
demonstrated that the angle of emergence of the conventional tracheal tube was different with different tubes, which may explain the difference in success rates of tracheal intubation. In our in vitro demonstration, the angles of emergence of the tracheal tube were 47° and 20° for normal and reserve orientation, respectively (Fig. 1). The 47° angle of emergence with normal orientation may direct the tracheal tube against the anterior portion of the upper airway (larynx, cricothyroid membrane, or trachea), resulting in failure of the tracheal tube advancement. Brain and colleagues also explained that the tracheal tube was unable to reverse its curvature from the point of exit from the ILMA into the trachea because of the additional curvature imposed by the metal shaft of the ILMA, thereby getting caught in the trachea. However, an emergence angle of 20° with reverse orientation may allow the tube to approach the larynx at a more optimal angle, resulting in higher intubation success rates.

This study was designed to evaluate the effects of conventional tracheal tube orientation on success of tracheal intubation via an ILMA in patients with exclusively Mallampati class 3 or 4. We found that success in intubation through the ILMA was high in Mallampati class 3 or 4 patients and are comparable with the success rate in patients with normal airways in the literature. Mallampati grading has been shown to be predictive of difficulties in direct laryngoscopy and tracheal intubation. However, studies have demonstrated that predictors of difficult laryngoscopic view do not bear any consistent relationship to the degree of difficulty in utilizing alternative intubating techniques such as the ILMA or lighted stylet whereby direct visualization of the larynx is not required.

Sore throat was slightly more frequent in our study compared with Lu and colleagues (17% vs 14.2%). The minor difference in incidence of sore throat may be attributed in part to the subjective nature of the visual analogue scale, the type and curvature of tracheal tube used, and the number of intubation attempts. The incidence of sore throat for LMA-Classic™ has been reported as 0–70%. There are several limitations to our study. First, the exact reason for unsuccessful passage of tracheal tube passage was not clear. Possible reasons include poor ILMA positioning, downfolded epiglottis, or the tip of the tracheal tube impinging on larynx or trachea. This study was designed to evaluate the success of intubation using a blind technique with two tracheal tube orientations. Further studies incorporating bronchoscopic visualization before and between intubating attempts may better illustrate the reasons for intubating failures. Secondly, patients in the study were of Chinese origin with relatively lower stature and weight, and anterior larynx. The results may not be generalizable to the other population categories.

In conclusion, the tracheal intubation was successful in 91.5% of patients through an ILMA with a conventional tracheal tube in Mallampati class 3 or 4 patients. The first-attempt success rate was higher in the reverse group compared with the normal group, but the overall success rate was similar between the groups. Conventional tracheal tube, instead of Fastrach™ silicone wire-reinforced tube, inserted through the ILMA may be considered as an option for airway management in patients with Mallampati 3 or 4 classification.

Funding
This work was supported in part by National Natural Science Foundation of China (NSFC) 30400423 and in part by 973 Program (2005CB522601).

References
8. Pandit JJ, MacLachlan K, Dravid RM, Popat MT. Comparison of times to achieve tracheal intubation with three techniques using the laryngeal or the intubating laryngeal mask airway. Anaesthesia 2002; 57: 128–32