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The Intubating Laryngeal Mask Airway Allows Tracheal Intubation When the Cervical Spine Is Immobilized by a Rigid Collar

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Summary

An intubating laryngeal mask airway (ILMA) facilitates tracheal intubation with the neck in neutral position, which is similar to the neck position maintained by a rigid cervical collar. However, a cervical collar virtually obliterates neck movement, even the small movements that normally facilitate airway insertion. We therefore tested the hypothesis that the ILMA facilitates tracheal intubation even in patients wearing a rigid cervical collar. In 50 cervical spine surgery patients with a rigid Philadelphia collar in place and 50 general surgery patients under general anaesthesia, we performed blind tracheal intubation via an ILMA. The time required for intubation, intubation success rate, and numbers and type of adjusting manoeuvres employed were recorded. Inter-incisor distance was significantly smaller (4.1 [0.8] cm *vs*. 4.6 [0.7] cm, mean [SD], $P<0.01$) and Mallampati scores were significantly greater ($P<0.001$) in the collared patients. ILMA insertion took longer (30 [25] *vs*. 22 [6] seconds), more patients required 2 insertion attempts (15 *vs*. 3; $P<0.005$), and ventilation adequacy with ILMA was worse ($P<0.05$) in collared patients. However, there were no significant differences between the collared and control patients in terms of total time required for intubation (60 [41] *vs*. 50 [30] seconds), number of intubation attempts, overall intubation success rate (96 *vs*. 98%), or the incidence of intubation complications. Blind intubation through an ILMA is thus a reasonable strategy for controlling the airway in patients who are immobilized with a rigid cervical collar, especially when urgency precludes a fiberoptic approach.

Keywords

anaesthesia; intubation; tracheal; laryngeal mask; cervical collar

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According to the Advanced Trauma Life Support (ATLS) protocol, a rigid cervical collar should be used to immobilize the neck in patients with possible cervical spine injury.[1] Fiberoptic intubation is ideal in these patients because neck mobilization and wide mouth opening are unnecessary. However, patients with suspected cervical spine injuries often require emergent intubation, a procedure that is commonly attempted under suboptimal field conditions.

Direct laryngoscopy in patients restrained by a rigid cervical collar is difficult at best and usually simply impossible.[2] An alternative to attempting direct laryngoscopy in patients stabilized by a cervical collar is to use an intubating laryngeal mask airway (ILMA, Laryngeal Mask Company, Henley-on-Thames, UK). However, formal evaluation of the ILMA in rigidly immobilized patients remains limited. We thus tested the hypothesis that the ILMA would facilitate tracheal intubation in the presence of a rigid cervical collar.

Methods

With approval of Human Research Committee at Tokyo Women's Medical University and informed consent, we studied 50 patients undergoing elective cervical spine surgery (Collar) and 50 patients undergoing various other surgical procedures with general anaesthesia (Control). Exclusion criteria included increased risk of pulmonary aspiration, unstable cervical spine, and ASA physical status IV.

Protocol

An appropriately sized rigid Philadelphia collar (Tracheostomy Philadelphia Collar, Philadelphia Cervical Collar Co., Thorofare, NJ, Fig. 1) was positioned around the neck of patients having spine surgery; the patients were positioned supine without a pillow. Patients having general surgery were also placed supine, but without a collar and with the head elevated 7 cm by a pillow.

Anaesthesia was induced with fentanyl 2 $\mu g.kg^{-1}$, propofol 2 $mg.kg^{-1}$, and after confirmation of facemask ventilation, vecuronium 0.1 $mg.kg^{-1}$ was given for muscle relaxation. Anaesthesia was maintained with 2% sevoflurane in oxygen during the study period.

In both groups, an ILMA lubricated with 8% lidocaine jelly was inserted using the one-handed rotational technique.[3] A size 3 ILMA was used for adults <160 cm tall, a size 4 ILMA was used for adults between 160 and 170 cm tall, and a size 5 for adults >170 cm tall. The cuff was inflated with air (size 3: 20 ml, size 4: 30 ml, size 5: 40 ml) and breathing circuit was connected to the ILMA. Ventilation *via* the ILMA was graded as: 1) adequate — rectangular capnographic wave form was obtained with no air leak at airway pressure of 20 cm H_2O, 2) possible — capnographic wave form was obtained with air leak at airway pressure below 20 cm H_2O, or 3) impossible — no capnographic wave form detected. When ventilation *via* the ILMA proved impossible, one attempt to reinsert the same sized ILMA was made.

Immediately after ventilation was confirmed or a second ILMA insertion attempt was performed, a lubricated silicone tracheal tube (Euromedical Industries, Kedah, Malaysia) was inserted in the ILMA and intubation was attempted by gently advancing the tube beyond epiglottic elevator bar. An 8.0-mm inner diameter tube was used for men and a 7.0-mm tube for women. If resistance was felt, the attempt was deemed as a failure and one of the following adjusting manoeuvres was performed before each additional attempt at intubation: 1) changing the ILMA size; 2) withdrawing the ILMA by no more than 6 cm with the cuff inflated followed by reinsertion (up-down manoeuvre); 3) adjusting the position of the ILMA until optimal seal was obtained (optimization manoeuvre); or 4) pulling the handle of the ILMA back towards the intubator (extension manoeuvre).

If no resistance was felt after the tube was advanced 7 cm beyond the epiglottic elevator bar, the cuff was inflated and the circuit was connected to confirm the correct ventilation through the tube with capnography. If oesophageal intubation occurred, an adjusting manoeuvre was performed before another intubation attempt. The ILMA was removed after successful tracheal intubation using a stabilizing rod. A single anaesthesiologist (R.K.), whose previous experience included more than 100 ILMA insertion-intubations, performed all ILMA insertion and intubation procedures.

We considered tracheal intubation to have failed if it could not be accomplished within 3 minutes or all adjusting manoeuvres failed. Spine surgery patients who were not successfully intubated were subsequently intubated fibreoptically via the nasal route after removal of the anterior piece of the rigid Philadelphia collar. Patients having general surgery were intubated conventionally with a Macintosh laryngoscope.

Measurements

Standard morphometric and demographic characteristics were recorded. We determined each patient's Mallampati score and mouth opening (inter-incisor distance) preoperatively; in the spine patients, both measurements were performed with the cervical collar in place.

Our primary endpoints were the overall intubation success rate, number of intubation attempts, number of ILMA insertion attempts, ILMA insertion time (the time from removal of the facemask to reappearance of capnographic wave form through the ILMA with positive pressure ventilation, or to the time of the second ILMA insertion attempt was completed if ILMA ventilation was a failure), intubation time (defined as the time from removal of the breathing circuit from ILMA to the reappearance of capnographic trace through the tracheal tube with no cuff leak with positive pressure ventilation), and total intubation time (ILMA insertion time plus intubation time). We also recorded the types of adjusting manoeuvres, frequency of oesophageal intubation, mucosal trauma (blood detected on the ILMA when it was removed from patient's mouth after completion of intubation), lip or dental injury, and hypoxia (SpO_2 < 95 %).

Data Analysis

Assuming the overall intubation success rate in the patients without neck immobilization would be 95%,[4] we decided that a 20% difference in overall intubation success rate between the groups would be clinically important. Forty-nine patients in each group would thus be necessary with $\alpha = 0.05$ and $\beta = 0.2$. We therefore enrolled 50 patients per group.

Patients with unsuccessful intubation were excluded from the analysis of intubation time and total intubation time.

Unpaired scored data were examined and compared by Mann-Whitney U-tests. The incidence of intubation complications, number of ILMA insertion attempts, and overall intubation success rate were tested by Fisher's exact tests or chi-square tests, as appropriate. Other descriptive data were compared using unpaired t-tests. Statistical analysis was performed using StatView version 5.0 (SAS Institute Inc. Cary, NC, USA) and Sample Power 2.0 (SPSS, Chicago, IL, USA). Values are expressed as means (SDs) unless otherwise stated; $P < 0.05$ was considered statistically significant.

Results

There were no statistically significant differences between the groups in terms of their demographic characteristics. The average Mallampati score was greater in the spine patients than in the Control group ($P < 0.001$), and the inter-incisor distance was smaller in the Collar group (4.1 [0.8] cm vs. 4.6 [0.7] cm, $P < 0.01$; Table 1).

ILMA insertion took longer in the Collar group (30 [25] seconds) than in the Control (22 [6] seconds, $P < 0.05$). More insertion attempts were required ($P < 0.01$), and adequacy of ILMA ventilation was worse ($P < 0.05$) in the Collar group. The overall intubation success rate was 96% in the Collar group and 98% in the Control group ($P > 0.99$; Table 2). Other variables related to ILMA insertion and intubation, such as intubation time, total intubation time, number of intubation attempts, and types of adjusting manoeuvres applied, were similar in the two groups (Table 2).

We failed to successfully intubate the tracheas of two patients in the Collar group and one in the Control group. During subsequent fibre-optic intubation in the failed collar patients, we did not observe any unusual upper airway anatomical characteristics. The control patient who required direct laryngoscopy had a Cormack and Lehane grade 1 laryngeal view and again, the anatomy appeared normal.

The incidences of intubation complications including mucosal trauma, dental and lip injury, and oesophageal intubation were similar in the two groups. No patient experienced dental injury or hypoxemia (SpO_2<95%); however, 3 in the Collar group had lip injury; 20 in the Collar and 18 in the Control group had mucosal trauma; and 7 patients in each group experienced oesophageal intubation.

Discussion

We evaluated blind intubation through an ILMA in patients wearing a rigid Philadelphia collar. Adequate or possible ventilation was established via the ILMA in 45 of 50 patients (90%) within two insertion attempts. Our overall success rate of 96% for blind intubation in this patient population did not differ significantly from our control patients who were intubated without a collar.

This is not the first report describing the use of an ILMA to facilitate intubation in patients wearing a cervical collar;[5–7] however, previous studies remain controversial. Ferson et al.[5] reported 100% success rate of blind intubation via the ILMA in 68 patients wearing a rigid Philadelphia collar within two attempts. However, their study was retrospective. Furthermore, the investigators cut out the chin portion of the collar to facilitate access to the patient's mouth, a manoeuvre that surely reduced efficacy of the collar and would ease ILMA insertion.

Moller et al.[6] reported 100% success rate of blind intubation via the ILMA in 17 patients wearing a stiff neck collar (Stiffneck Sellect; Laerdal Medical Corp, Wappinger's Falls, NY). However, using same type of collar with application of cricoid pressure, Wakeling and Nightingale[7] succeeded in blindly intubating only 2 of 10 patients. The success rate of ventilation and blind intubation via the ILMA in this study[7] might have been exacerbated by application of cricoid pressure as observed in patients with normal airway.[8]

We did not find any differences in the intubation success rate, number of intubation attempts, or types of adjusting manoeuvres applied between our two study groups. It thus appears that when positioned properly, the rigid Philadelphia collar does not greatly alter upper airway anatomy. However, we did find that ILMA insertion time was longer, more insertion attempts were required, and that ventilation through the ILMA was worse in rigidly immobilized patients. Although there are statistically significant differences in inter-incisor distance between our groups, this small difference seems clinically unimportant. The more likely explanation for the difficulty in insertion of the ILMA in the collared patients is that the collar prevented small movement of the head and neck that might have facilitated insertion of the device.

Our protocol has several limitations. First, we only studied patients undergoing elective surgery without an unstable cervical spine. Oesophageal intubation occurred in 14% of the patients, and 34% of patients required multiple intubation attempts. Significant Prolonged intubation time may not be acceptable in an emergency situation with a patient with gastric paresis, or respiratory or cardiac insufficiency. Furthermore, the ILMA exerts considerable pressure against cervical vertebrae,[9] and possible neurological deterioration must be considered before using the ILMA in patients with an unstable cervical spine.

A second limitation of our study was that we did not have a positive control (i.e. comparison of the ILMA with another intubation technique in the presence of a collar). Although there is no gold standard technique for emergent airway management of a patient with possible cervical spine injury, several techniques can be used in this scenario. Blind nasal intubation is successful in more than 90% of patients, but it requires multiple attempts in 67–90% of patients.[10–12] Thus, it may be slower and cause trauma to the nose or pharynx. There are also objections to the use of the nasal route as it is dangerous in the presence of basal skull fracture.[13] The fibreoptic technique in awake patients allows intubation under direct vision and has success rate near 100% in skilled hands.[14] However, successful fibreoptic tracheal intubation requires a cooperative patient and a secretion-free and blood-free airway.

Direct laryngoscopy with the aid of a gum elastic bougie is successful in more than 90% of patients whose neck movements are restricted, although 20% of the patients require multiple attempts.[15,16] Due to blind insertion of a bougie into the trachea, oesophageal intubation may occur in some patients. Prism laryngoscope improves laryngoscopic view compared to the Macintosh blade;[17,18] however the use of a prism significantly increases the difficulty of intubation as it interferes with passage of the endotracheal tube,[17] prolongs intubation time, and produces more failed intubation attempts than does the Macintosh blade.[19,20] From these results, the prism laryngoscope may not be recommended in this scenario.

The Bullard laryngoscope was used in real and simulated cervical spine injury patients with a success rate of 85–100% and intubation time of ~40 seconds.[21–23] The device can be used in awake patients or under general anaesthesia, and the time required for intubation is reasonable. However, blood and secretion in the airway compromise the success rate of this technique as in the case of the fibreoptic technique. Compared to above-mentioned techniques, the ILMA does not need a secretion-free and blood-free airway, and even when the intubation is not possible, the ILMA acts as ventilation device with high success rate.

In conclusion, blind intubation through an ILMA is thus a reasonable strategy for controlling the airway in patients who are immobilized with a rigid cervical collar, especially when urgency precludes a fiberoptic approach.

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Figure 1.
Tracheostomy Philadelphia Collar (Philadelphia Cervical Collar Co., Thorofare, NJ,).

Table 1

Demographic and airway assessment data.

	Collar (N=50)	Control (N=50)	*P* Value
Age (yr)	58 (15)	55 (16)	0.34
Sex (M/F)	22/28	22/28	>0.99
Height (cm)	158 (8)	160 (9)	0.23
Weight (kg)	55 (11)	58 (10)	0.17
Mallampati Score (1/2/3/4)	12/24/12/2	33/14/3/0	<0.001
Inter-incisor distance (cm)	4.1 (0.8)	4.6 (0.7)	<0.01

Data presented as means (SDs) or number of patients.

Table 2

ILMA insertion and intubation data.

	Collar (N=50)	Control (N=50)	*P* Value
ILMA insertion time (sec)	30 (25)	22 (6)	<0.05
Intubation time (sec)	31 (33)	28 (6)	0.69
Total intubation time (sec)	60 (41)	50 (30)	0.17
ILMA insertion attempts; 1/2 (n)	35/15	47/3	<0.005
Grade of ILMA ventilation (n)			<0.05
Adequate	37	45	
Possible	8	4	
Impossible	5	1	
Intubation attempts (n)			0.41
1	33	36	
2	8	9	
3	5	3	
4	4	2	
5	0	0	
Overall intubation success (n)	48	49	>0.99
Adjusting manoeuvres (n)*			
None	33	36	0.52
ILMA size change	8	6	0.56
Up-down	10	5	0.15
Optimization	7	8	0.97
Extension	5	2	0.39

Data presented as means (SDs) or number of patients.

* Some patients had more than one adjusting manoeuvre.