Reports of Investigation

Intubating laryngeal mask for fiberoptic intubation - particularly useful during neck stabilization

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Purpose: To assess the ease of fibroscope-assisted tracheal intubation while the patient's head and neck were placed in the neutral or the manual in-line position, and to determine if the intubating laryngeal mask facilitated fiberoptic intubation in these positions.

Methods: In 84 patients, the patient's head and neck were placed in the neutral position (pillow placed under occiput), and in another 40 patients the head and neck were stabilized by the manual in-line method (no pillows under occiput). In both groups, after induction of anesthesia with 2.0 - 2.5 mg·kg⁻¹ propofol, 50 - 100 µg fentanyl and 1.0 mg·kg⁻¹ vecuronium, patients were allocated randomly into two groups: in Group C tracheal intubation was attempted using only a fibroscope, whereas in Group L fiberoptic intubation through the intubating laryngeal mask was attempted.

Results: In group C the success rate of fiberoptic tracheal intubation within two minutes was higher in the neutral position (31 of 42 patients (73%)) than in the manual in-line position (8 of 20 patients (40%)). In contrast, in group L the success rate was similar between the two positions. Tracheal intubation was easier in group L than in group C ($P < 0.01$ or 0.001) and the time for intubation was shorter in group L than in group C in both head and neck positions.

Conclusions: Fiberoptic tracheal intubation was more difficult in the manual in-line position than in the neutral position. The intubating laryngeal mask facilitated fiberoptic intubation in both positions.

Objectif : Évaluer la facilité de l'intubation endotrachéale fibroscopique alors que la tête et le cou du patient sont en position neutre ou en position en ligne manuelle. Déterminer aussi si le masque laryngé d'intubation facilite l'intubation fibroscopique dans ces positions.

Méthode : Chez 84 patients, la tête et le cou ont été placés en position neutre (un oreiller sous l'occiput) et chez 40 autres patients, la tête et le cou ont été stabilisés manuellement par la méthode en ligne (sans oreiller). Après l'induction de l'anesthésie avec 2,0 - 2,5 mg·kg⁻¹ de propofol, 50 - 100 µg de fentanyl et 1,0 mg·kg⁻¹ de vécuronium, les patients ont été répartis au hasard en deux groupes : le groupe C où l'intubation endotrachéale a été tentée en utilisant seulement le fibroscope, tandis que dans le groupe L, l'intubation fibroscopique a été réalisée au travers du masque laryngé d'intubation.

Résultats : Dans le groupe C, le taux de succès de l'intubation endotrachéale fibroscopique, réalisée en moins de deux minutes, a été plus élevé chez les patients en position neutre (31 des 42 patients ou 73 %) que chez les patients en ligne (8 des 20 patients ou 40 %). Par ailleurs, dans le groupe L, le taux de succès a été similaire pour les deux positions. L'intubation endotrachéale a été plus facile dans le groupe L que dans le groupe C ($P < 0,01$ ou $0,001$) et le temps nécessaire à l'intubation a été plus court dans le groupe L que dans le groupe C pour les deux positions.

Conclusion : L'intubation endotrachéale fibroscopique a été plus difficile selon la position manuelle en ligne que selon la position neutre. Le masque laryngé d'intubation a facilité l'intubation fibroscopique pour les deux positions expérimentées.

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THE fiberoptic bronchoscope is useful to facilitate tracheal intubation in patients with difficult airways, but it may be difficult to advance a tracheal tube over the fibroscope in 40–90% of cases.^{1–5} This difficulty depends on the size of the fibroscope and tracheal tube: the larger tracheal tube (or greater the gap between a fibroscope and tracheal tube), the greater the difficulty in passing the tube over the fibroscope.^{1,2} The position of the patient's head and neck may also alter the ease of fibroscope-aided tracheal intubation. For example, a restricted movement of the head and neck either by pathological changes or by active stabilization may make location of the glottis using the fibroscope more difficult. Although a fiberoptic bronchoscope has been considered to be useful for tracheal intubation in these circumstances, there have been no reports of the ease and success rate of fiberoptic tracheal intubation during stabilization of the head and neck.

The intubating laryngeal mask is useful in facilitating tracheal intubation,^{6–9} but its success rate at the first attempt can be as low as 50% when the tube is advanced blindly.⁶ The use of the fibroscope should increase the success rate of intubation, but there have been only a few studies of this method^{7,8} and none compared the ease of fiberoptic tracheal intubation with and without the use of the intubating laryngeal mask.

The main aims of our study were to determine (1) if the intubating laryngeal mask facilitated fiberoptic tracheal intubation in patients with normal head and neck movement, (2) the ease of a fibroscope-aided tracheal intubation during the manual in-line stabilization of the head and neck, and (3) if the intubating laryngeal mask has a role in fiberoptic intubation in the patient with restricted neck movement.

Patients and Methods

After obtaining institutional research ethics committee approval and written informed consent, we studied 124 patients, ASA physical status 1 or 2, aged 18–75 yr, undergoing elective surgery. Patients were excluded if they had pathology of the neck, upper respiratory or alimentary tracts, if they were at risk of pulmonary aspiration of gastric contents or if difficult tracheal intubation or ventilation was predicted. Patients with Mallampati class 3 or 4^{10,11} were also excluded. Diazepam, 5 mg *po*, was given on the night before anesthesia; no antisialagogues were given.

Phase 1—Neutral head and neck position

In the first set of 84 patients, tracheal intubation was attempted while the patient's head, but not the neck, was placed on a firm pad (approximately 7 cm in

height). This head and neck position was arbitrarily defined as the neutral position. Anesthesia was induced with 2.0–2.5 mg·kg⁻¹ propofol, 50–100 µg fentanyl and 1.0 mg·kg⁻¹ vecuronium, and was maintained with sevoflurane in oxygen. The patients were then allocated randomly into two groups, using block randomization (in blocks of 12). In one group (control group or Group C), tracheal intubation was attempted using only a fiberoptic bronchoscope, whereas in the other group (Group L), fiberoptic intubation through the intubating laryngeal mask was attempted. In both groups, a fibroscope with an outer diameter of 3.5 mm was used. We used a Mallinckrodt reinforced tracheal tube (Athlone, Ireland), since the specially tailored tube (Euromedical, Kadal, Malaysia) for the intubating laryngeal mask was not available at our hospital, and since the Mallinckrodt tube has been considered to be suitable for this purpose.¹ The connector of the Mallinckrodt tube is glued to the tube so that it is not possible to remove the laryngeal mask after tracheal intubation; therefore, the connector was detached from the tube using a blunt spatula before insertion.^{1,2} A 7.0-mm ID tracheal tube was used in women and an 8.0-mm ID tube in men. In group L, the laryngeal mask was removed after completion of the study.

In group C, tracheal intubation was attempted using the method described previously,¹ except that no attempts were made to extend the head on the neck. After neuromuscular blockade had been obtained, the jaw was pulled forward by an assistant. The fibroscope, which was passed through a tracheal tube, was inserted orally into the trachea and the tube was passed over it. No airway intubator was used.

In group L, the intubating laryngeal mask was inserted using the method described by Brain *et al.*⁶ A size # 5 was used in men and a # 4 in women unless it was judged to be too large when one size smaller was used. If ventilation was inadequate, another attempt at insertion was made. A tracheal tube was inserted into the laryngeal mask, the fibroscope was passed through these into the trachea, and the tracheal tube was passed over the fibroscope.

In both groups, if it was difficult to intubate the trachea, rotation of the tube or maneuvering of the patient's head and neck was allowed. In group L, adjusting the position of the laryngeal mask using the metal guiding handle⁶ was allowed. Only one attempt, two minutes for insertion of the fibroscope and two minutes for tracheal intubation over the fibroscope, was allowed for tracheal intubation. The ease of tracheal intubation was assessed and scored in four grades:¹ 'Optimal': no collision (hold-up) encountered; 'Suboptimal': hold-up, relieved by rotation of the tube

TABLE I Patient characteristics (mean $\pm$ SD for the age and weight). Group C: conventional fiberoptic tracheal intubation (without the use of the intubating laryngeal mask); Group L: fiberoptic tracheal intubation through the intubating laryngeal mask.

	<i>Neutral position</i>		<i>Manual in-line position</i>	
	<i>Group C</i> (<i>n</i> = 42)	<i>Group L</i> (<i>n</i> = 42)	<i>Group C</i> (<i>n</i> = 20)	<i>Group L</i> (<i>n</i> = 20)
Height (cm)	161 $\pm$ 7	162 $\pm$ 8	165 $\pm$ 8	163 $\pm$ 10
Weight (kg)	62 $\pm$ 9	62 $\pm$ 9	64 $\pm$ 10	57 $\pm$ 11
Sex (M/F)	25/17	27/15	15/5	11/9

TABLE II Ease of tracheal intubation over the fibroscope (number of patients (%)). Only one attempt, two minutes for insertion of the fibroscope and two minutes for tracheal intubation over the fibroscope, was allowed for tracheal intubation. There is a significant difference in the ease of tracheal intubation with and without the use of the intubating laryngeal mask during the neutral head and neck position ($P < 0.01$) and for the manual in-line position ($P < 0.001$). Group C: conventional fiberoptic tracheal intubation (without the use of the intubating laryngeal mask); Group L: fiberoptic tracheal intubation through the intubating laryngeal mask.

<i>Group</i>	<i>Optimal</i>	<i>Suboptimal</i>	<i>Difficult</i>	<i>Failure</i>
<i>Neutral position</i>				
Group C (<i>n</i> = 42)	14 (33%)	5 (12%)	12 (29%)	11 (26%)
Group L (<i>n</i> = 42)	27 (64%)	7 (17%)	3 (7%)	5 (12%)
<i>Manual in-line position</i>				
Group C (<i>n</i> = 20)	4 (20%)	3 (15%)	1 (5%)	12 (60%)
Group L (<i>n</i> = 20)	13 (65%)	2 (10%)	4 (20%)	1 (5%)

once; 'Difficult': hold-up, requiring more than one rotation of the tube, alteration in the patient's head or neck position or maneuvering the metal handle of the intubating laryngeal mask; and 'Failure': failure of the attempt at fiberoptic tracheal intubation within the above time limits.

In patients in whom tracheal intubation was successful, the time from removal of the facemask to insertion of the fibroscope into the trachea, and the time from the insertion of the fibroscope to connection of the breathing system after successful tracheal intubation, were measured. In group L, the time from removal of the facemask to insertion of the fibroscope into the trachea was the sum of the time taken for insertion of the laryngeal mask and time to insertion of the fibroscope. When insertion of the laryngeal mask failed at the first attempt, but succeeded at the second attempt, the sum of the times taken for the first and the second attempts was recorded.¹

Phase 2—Manual in-line position

In the second set of 40 patients, tracheal intubation was attempted while the patient's head and neck were stabilized. Pillows were removed and the patient's head and neck stabilized by an assistant who held the sides of the neck and the mastoid processes (manual in-line stabilization).

After induction of anesthesia and neuromuscular relaxation, the patients were allocated randomly into two groups, and either tracheal intubation using a fiberoptic bronchoscope (Group C) or fiberoptic intubation through the intubating laryngeal mask (Group L) was attempted. The procedures were the same as in Phase 1.

Statistical analysis

Chi-squared for trend was used to compare the ease of tracheal intubation between groups. P values < 0.05 were considered significant. The 95% confidence intervals (CI) for the difference in the success rate of intubation, in the proportion of the 'Optimal' intubation, and in median time between the groups were calculated.

For the Phase 1 study, the reported proportion of the Optimal intubation using an 8.0 mm ID tracheal tube (without the use of the laryngeal mask) is up to 20%.¹⁻³ We considered that a method which would increase the proportion by 30% to be clinically important. To detect this difference, with a power of 80%, 84 patients would be required. For the Phase 2 study, a preliminary study indicated that fibroscopy in group C might often fail, and the success rate would be 50% or less. We considered that a method which would increase the success rate to 90% to be clinically important. To detect this difference (40% or greater), with a power of 80%, 40 patients would be required.

Results

The patients' characteristics were similar between the groups in Phase 1, whereas in Phase 2 body weight in group C was somewhat heavier than in group L, possibly due to a greater proportion of men in group C (Table I).

Neutral head and neck position

When the patient's head and neck were placed in the neutral position, it was possible to insert the fibroscope into the trachea in 37 of 42 patients (88%) in group C. In group L, insertion of the intubating laryngeal mask was always successful at the first attempt. Fibroscopy through the laryngeal mask succeeded in 38 of 42 patients [90%].

Tracheal intubation was easier in group L than in group C ($P < 0.01$) (Table II). The difference in the success rate between groups was 14% (95%CI: -2% - 31%) and in the optimal intubation grade was 31% (95%CI: 12% - 51%).

TABLE III Time (s) for tracheal intubation (median (range)) in whom tracheal intubation succeeded. T_1 : time from removal of a facemask to insertion of a fibroscope into the trachea; T_2 : time from insertion of the fibroscope into the trachea to connection of the breathing system after tracheal intubation. Group C: conventional fibreoptic tracheal intubation (without the use of the intubating laryngeal mask); Group L: fibreoptic tracheal intubation through the intubating laryngeal mask.

	T_1	T_2	Total
Neutral position			
Group C ($n = 37$)	22.0 (10 - 120)	15.0 (5 - 119)	44.0 (20 - 190)
Group L ($n = 38$)	28.0 (10 - 82)	6.0 (3 - 53)	34.0 (18 - 102)
95% confidence limits for median difference			
Group C-L	[-10.0, 6.0]	[4.0, 10.0]	[-2.0, 20.0]
Manual in-line position			
Group C ($n = 8$)	47.5 (35 - 120)	13.5 (7 - 20)	59.0 (55 - 132)
Group L ($n = 19$)	20.0 (13 - 82)	6.0 (2 - 50)	26.5 (14 - 90)
95% confidence limits for median difference			
Group C-L	[20.0, 74.0]	[3.0, 11.0]	[27.0, 73.0]

In patients in whom tracheal intubation was successful, 95% CI of differences indicated that there was no marked difference between groups in the time for inserting a fibroscope into the trachea, whereas the time for tracheal intubation over the fibroscope was significantly shorter in group L than in group C (Table III). The median difference for total time for tracheal intubation (from removal of a facemask to connection of the breathing system after tracheal intubation) between groups was 7 sec (95%CI: -2.0 sec—20 sec).

Manual in-line position

When the patient's head and neck were stabilized by the manual in-line method, the fibroscope could be inserted into the trachea within two minutes in only eight of 20 patients (40%) in group C. In group L, the intubating laryngeal mask could be inserted at the first attempt in 19 patients and the remaining one at the second attempt. Fibrescopy through the laryngeal mask succeeded in 19 of 20 patients [95%].

Tracheal intubation was easier in group L than in group C ($P < 0.001$) (Table II). The difference between groups in the success rate was 55% (95%CI: 32% - 78%) and in the optimal intubation grade was 45% (95%CI: 18% - 72%).

In patients in whom tracheal intubation succeeded, 95% CI of differences indicated that both time for inserting a fibroscope into the trachea and time for tracheal intubation over the fibroscope were shorter in group L than in group C (Table III).

Neutral vs Manual in-line positions

When attempts were made to insert the fibroscope into the trachea (without the use of the intubating laryngeal mask), the success rate of fibrescopy was markedly lower during the manual in-line stabilization than during the neutral head and neck position, with a difference of 44% (95%CI: 24% — 72%). As a consequence, the success rate of tracheal intubation was markedly lower during manual in-line stabilization (8 of 20 patients (40%)) than during the neutral head and neck position (31 of 42 patients (73%)). In contrast, when the intubating laryngeal mask was used, there were no marked difference in the success rate of fibrescopy (difference: 4.5%; 95%CI: -8% — 17.5%) and of tracheal intubation (difference: 7%; 95%CI: -7% — 21%) between the two head and neck positions.

Discussion

We have found that the intubating laryngeal mask facilitated fibreoptic tracheal intubation, fibreoptic intubation (without the use of the intubating laryngeal mask) was often difficult during manual in-line head and neck stabilization, and the intubating laryngeal mask has a potential role in fibreoptic intubation with the patient with restricted neck movement.

Fibreoptic tracheal intubation was easier and faster with the use of the intubating laryngeal mask airway. The success rate of fibreoptic tracheal intubation through the intubating laryngeal mask at the first attempt (37 of 42 patients (88%)) in our study was similar to that in previous studies using the intubating laryngeal mask^{7,8} and using the conventional laryngeal mask (90% to 95%).^{1,13} Previous studies have reported that, when tracheal intubation was attempted blindly through the intubating laryngeal mask the success rate was high (93-100%).^{8,9,14} However, this blind intubation may fail in 50-60% of patients at the first attempt^{8,9,14} and might damage the larynx and surrounding tissues, such as impingement of the epiglottis into the laryngeal inlet¹⁵ or perforation of a esophageal pouch.¹⁶ Therefore, caution is required for the blind technique,¹⁷ particularly when there is resistance during the advancement of a tracheal tube or when ventilation via the mask is suboptimal. Therefore, we recommend the use of a fibroscope whenever it is available.

Although the success rate of fibreoptic intubation through the intubating laryngeal mask was high, some difficulty was encountered during tracheal intubation in 15 of 42 patients (36%), even when the patient's head and neck were placed in the optimal neutral position. In contrast, when the conventional laryngeal mask was used, tracheal intubation was easy in most

patients.¹ The reason for this discrepancy is not clear. One possibility is that a larger tracheal tube (7.0-mm ID in men and 8.0-mm ID in women) was used for the intubating laryngeal mask than for a laryngeal mask (6.0-mm ID). It is not known if there is a significant difference in the ease of tracheal intubation between a larger tube and a smaller tube through the intubating laryngeal mask.

Another possibility for the difficulty in tracheal intubation through the intubating laryngeal mask was difficulty in advancing the fibroscope beyond the aperture of the mask. For example, when the epiglottis partially obstructs the aperture of the mask, it is sometimes possible to advance a fibroscope through the conventional laryngeal mask into the trachea, whereas insertion of the fibroscope through the intubating laryngeal mask may be difficult if the downfolded epiglottis prevents lifting the 'epiglottic elevating bar'. In fact, it was sometimes necessary to maneuver the metal handle of the laryngeal mask to shift the position of the epiglottis to advance the fibroscope beyond the bar.

The ease of insertion of the fibroscope into the trachea (without the use of the intubating laryngeal mask) was markedly altered by the patient's head and neck position: fibroscopy was much more difficult during the manual in-line position than during the neutral position (Table I). One study has shown that placement of a pillow under the patient's head opens the oropharynx.¹⁸ In addition, chin lift, thrusting the jaw forward or extension of the head also widens the oropharyngeal space.^{19,20} In our patients, during the manual in-line position, it was often difficult to advance the fibroscope through the space between the epiglottis and posterior pharyngeal wall, and it was possible to insert the fibroscope into the trachea within two minutes in only eight of 20 patients.

When the intubating laryngeal mask was used, there were no marked differences between the neutral and manual in-line positions in the ease of fibroscopy and tracheal intubation (Table I). This is consistent with previous reports of successful intubation through the intubating laryngeal mask after failed or previously difficult fibreoptic tracheal intubation.²¹⁻²³ In addition, the success rate of blind intubation through the intubating laryngeal mask in patients with difficult airways was similar to, or even greater than, that in patients with normal airways.⁶ This may indicate that when the intubating laryngeal mask is inserted successfully, factors producing a "difficult airway" (e.g. restricted head and neck position) may often not markedly reduce the ease of fibroscopy and subsequent tracheal intubation.

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