

The gum elastic bougie eases tracheal intubation while applying cricoid pressure compared to a stylet

[La bougie flexible, comparée au stylet, facilite l'intubation endotrachéale pendant la compression cricoïdienne]

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Purpose: To compare the ease of tracheal intubation facilitated by the gum elastic bougie or the malleable stylet while applying cricoid pressure.

Methods: Sixty American Society of Anesthesiologists I–III adult patients undergoing elective surgeries participated in this study. After induction of anesthesia with 2.5 mg·kg⁻¹ propofol and vecuronium 0.1 mg·kg⁻¹, the laryngeal view was assessed without and with cricoid pressure. Patients were allocated randomly into two groups: a gum elastic bougie or stylet group. One of the two devices was used for tracheal intubation while applying cricoid pressure. The duration and ease of tracheal intubation was recorded.

Main results: In 58 patients, the trachea was intubated at the first attempt. In the stylet group, tracheal intubation was difficult and needed more time, especially when the glottic opening was not visible. In the bougie group, the duration and ease of intubation was not influenced by laryngeal view. In the remaining two patients with Cook's modified 3b laryngeal view, it was impossible to intubate the trachea with these devices.

Conclusions: Applying cricoid pressure worsened laryngeal view. The use of a gum elastic bougie was more effective than the use of a stylet to facilitate intubation.

Objectif: Comparer l'intubation endotrachéale facilitée par la bougie flexible ou le stylet maniable pendant l'application de la compression cricoïdienne.

Méthode: Soixante patients adultes, d'état physique ASA I–III, devant subir une intervention chirurgicale réglée ont participé à l'étude. Après l'induction de l'anesthésie avec 2,5 mg·kg⁻¹ de propofol et 0,1 mg·kg⁻¹ de vécuronium, la visualisation du larynx a été évaluée avec et sans compression cricoïdienne. Les patients ont été répartis au hasard en deux groupes pour l'intubation endotrachéale avec la bougie flexible

ou le stylet pendant l'application de la compression cricoïdienne. La durée et la facilité de l'intubation ont été notées.

Constatations principales: Chez 58 patients, l'intubation a été réussie au premier essai. Dans le groupe avec stylet, l'intubation a été difficile et a exigé plus de temps, surtout quand l'ouverture glottique n'était pas visible. Dans le groupe avec bougie, la durée et la facilité de l'intubation n'ont pas été influencées par la visualisation du larynx. Chez les deux patients restants qui présentaient une vue laryngée de classe 3b modifiée de Cook, il a été impossible de réaliser l'intubation avec l'un ou l'autre instrument.

Conclusion: L'application de la compression cricoïdienne a nui à la visualisation du larynx. La bougie flexible a été plus efficace que le stylet pour faciliter l'intubation.

AIRWAY management in a patient with a full stomach poses a challenge to the anesthesiologist. To prevent regurgitation and aspiration of gastric contents, application of cricoid pressure has become standard practice. However, applying cricoid pressure may cause difficulty with tracheal intubation by distorting the larynx¹⁻⁴ and some patients are difficult to intubate after induction of anesthesia without preoperative signs of a difficult airway.⁵ To overcome this difficulty, the use of a stylet is recommended for the patient with a full stomach.⁶ In the United Kingdom, however, a gum elastic bougie is used routinely as an aid to difficult tracheal intubation.⁷⁻⁹ In a simulated difficult intubation

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Accepted for publication January 23, 2003.

Revision accepted May 2, 2003.

model, Gataure *et al.*¹⁰ demonstrated that the success rate of tracheal intubation was higher with a gum elastic bougie than with a stylet. Another study also described that the gum elastic bougie was useful during manual in-line neck stabilization with cricoid pressure,¹¹ although it was not compared with a stylet. Comparative studies evaluating a gum elastic bougie and a stylet for rapid sequence induction during application of cricoid pressure in humans are lacking.

The aim of our study was to compare the ease of tracheal intubation facilitated by a gum elastic bougie or a malleable stylet while applying cricoid pressure.

Methods

After obtaining approval from our Hospital Review Board and written informed consent from each patient, we studied 60 patients, American Society of Anesthesiologists (ASA) physical status I–III, aged 22–93 yr, undergoing elective surgery, in whom tracheal intubation was indicated. Patients under 20 yr of age, who had a history of surgery in the neck, pharynx and larynx or were at risk of pulmonary aspiration of gastric contents were excluded from the study. At the preoperative visit, the Mallampati class was assessed.¹²

Preoperatively, the patients received diazepam orally or no medication. In the operating theatre, patients were monitored with an electrocardiogram, indirect blood pressure, pulse oximetry and capnogram. After preoxygenation for three minutes, general anesthesia was induced with propofol 2.5 mg·kg⁻¹. Muscular relaxation was provided by vecuronium 0.1 mg·kg⁻¹ and adequacy of muscle relaxation was confirmed with a peripheral nerve stimulator. Anesthesia was maintained with sevoflurane in oxygen during the study period.

The patient's head and neck were kept in optimal intubating position with a pillow (5 cm in height) under the occiput during intubation. Laryngoscopy was performed with a size 3 Macintosh blade in order to grade the laryngeal view. In this study, Cook's modified laryngeal classification was used (grade 1, most of the cords visible; grade 2a, posterior cord visible; grade 2b, only arytenoids visible; grade 3a, epiglottis visible and liftable; grade 3b, epiglottis adherent to pharynx; grade 4, no laryngeal structures seen).¹³ These grades are categorized as 'easy' (grade 1 and 2a) 'restricted' (grade 2b and 3a) and 'difficult' (grade 3b and 4).¹³ If the view was not grade 1, external laryngeal pressure was applied to the larynx to improve it. After recording the best view of the larynx, a brief period of controlled hyperventilation on 100% oxygen was resumed. The patients were allocated into the two groups using a sealed envelope method.

Single handed cricoid pressure was applied by an

operating nurse. Before each attempt, the correct force of 3.06 kg (30N) was simulated on a set of weighting scales³ and the position of the cricoid cartilage was checked by the anesthesiologist performing the intubation (T.N.). Laryngoscopy was repeated while applying cricoid pressure, and the view of the larynx was graded again. Cricoid pressure was maintained until intubation and inflation of the cuff were completed.

In all groups an 8.0-mm internal diameter (ID) tracheal tube (Portex Profile Softseal®, UK) was used in males and a 7.5-mm ID tube in females. All attempts at tracheal intubation were performed by one investigator (T.N.) who was well versed in the use of a bougie and a stylet. The intubation procedure was performed according to study protocols as described below.

Intubation protocols

BOUGIE GROUP

In the bougie group, a well-lubricated gum elastic bougie (Eschmann tracheal tube introducer, Portex, Kent, UK) was gently passed through the vocal cords. If the glottis was not visible, the bougie was passed blindly below the epiglottis toward the vocal cords. Correct placement in the trachea was indicated by the sensation of 'clicks' as the bougie slid over the tracheal rings.¹⁴ If 'clicks' sensation was absent, the bougie was advanced deeply to feel 'distal hold up' as the bougie reaches the small bronchi.¹⁴ Once the bougie was thought to be in the trachea, another assistant steadied the tip of the bougie and, with the laryngoscope still held in the mouth, the tracheal tube was threaded over the bougie by the anesthesiologist. Just before passing through the cords, the tracheal tube was rotated a quarter-turn anticlockwise so that the bevel of the tube faced posteriorly, easing its passage into the larynx.¹⁵ Furthermore, if the tube hung up on the epiglottis or arytenoid, further rotation was added. The bougie was withdrawn and the breathing circuit was connected to the tube. Successful tracheal intubation was confirmed by chest wall movement and capnography.

STYLET GROUP

A malleable metal stylet was well lubricated and placed in the tracheal tube. The distal end was bent into a 'hockey stick' shape as recommended in a standard textbook.¹⁶ Once the tube was thought to have entered the trachea, the stylet was withdrawn and the breathing circuit was connected. Correct tracheal intubation was confirmed in the same way.

Safety management

In both groups, each attempt at tracheal intubation was allowed for 60 sec. If the trachea could not be

intubated at the first attempt, one more attempt was allowed. If tracheal intubation failed after two attempts, another method (cross-over to the other device), was used and one more attempt was allowed. If the tracheal tube was passed into the esophagus at the first attempt, a second attempt was not allowed and the study was terminated. The lungs were ventilated with sevoflurane in oxygen between the attempts. If the arterial hemoglobin oxygen saturation (SpO₂) decreased below 95%, the study was abandoned immediately and appropriate treatment was instituted. If all attempts at intubation failed, the case was excluded from the study and the trachea was intubated using another method.

Duration and ease of tracheal intubation

In all patients in whom tracheal intubation was successful, the time from removal of the facemask to successful tracheal intubation (confirmed by a normal capnogram) was recorded.

In the bougie group, the time from removal of the facemask to the correct placement of the bougie by confirming 'click' or 'distal hold up' sensation (T1) and the time from the placement of the bougie to successful tracheal intubation (T2) were measured separately. Total time for intubation was the sum of T1 and T2. When tracheal intubation failed at the first attempt, but succeeded at the second attempt, the sum of the time taken for the first and the second attempts was noted (excluding the ventilation period between attempts).

TABLE I Patient characteristics

	<i>Bougie group</i> (n = 30)	<i>Stylet group</i> (n = 30)
Sex (M/F)	13/17	14/16
Age (yr)	59 ± 19	60 ± 17
Height (cm)	157 ± 12	156 ± 8
Weight (kg)	56 ± 11	57 ± 9
ASA physical status (1/2/3)	10/19/1	13/15/2
Mallampati class (1/2/3)	16/12/2	14/14/2

Mean ± standard deviation for the age, height and weight. ASA = American Society of Anesthesiologists. No significant difference between groups.

TABLE II View of the glottis at laryngoscopy

	<i>Grade (Cook's modified laryngeal classification)</i>					<i>Total</i>
	<i>1</i>	<i>2a</i>	<i>2b</i>	<i>3a</i>	<i>3b</i>	
Optimal position	31 (51.7)	8 (13.3)	15 (25)	5 (8.3)	1 (1.7)	60 (100)
While applying cricoid pressure	14 (23.3)	11 (18.3)	19 (31.7)	14 (23.3)	2 (3.3)	60 (100)

Number (%).

The ease of tracheal intubation with a bougie or a stylet was assessed using a visual analogue scale (VAS). The scale, a line in 100 mm, was used for each attempt; the word 'easy' was described on the left side of the line, and 'difficult' on the right side. If more than two attempts were needed, VAS was scored as 100 mm.¹⁷

Data and statistical analysis

Values are expressed as mean ± standard deviation (SD) for demographic data. Comparisons of demographic data were analyzed with unpaired t tests or Chi squared tests. The change of laryngeal classification while applying cricoid pressure was analyzed by Chi squared test. T1, T2 and the total time for intubation were analyzed using unpaired t test. VAS scores were analyzed by repeated measures analysis of variance (ANOVA) with the Scheffé F test between the combination of method and laryngeal view. A P value of < 0.05 was considered statistically significant.

From our preliminary observation of five patients in the malleable stylet group with a restricted laryngoscopic view, we found that the mean VAS for the ease of tracheal intubation was 60 mm with a SD of 27 mm. We considered that a clinically important difference in the VAS for the ease of tracheal intubation with the bougie group would be at least 30 mm. Thirty-three patients with a restricted laryngoscopic view would be required to detect this difference with a power of 90%.

Results

Patient characteristics are shown in Table I. No significant differences were noted between the two groups with respect to sex, age, height, weight, ASA physical status and Mallampati classification. During the procedure, SpO₂ did not decrease below 95% in any patient.

Change of laryngeal classification when applying cricoid pressure

The laryngeal views obtained during laryngoscopy in the optimal position, and while applying cricoid pressure, are shown in Table II. There was no grade 4 laryngoscopy in this study. Laryngeal view remained

TABLE III Time for successful tracheal intubation

View of larynx	Easy	Restricted	P
Bougie group	n = 12	n = 17	
T1	14 ± 2	15 ± 3	0.4
T2	19 ± 3	19 ± 3	0.73
Total time	31 ± 7	33 ± 4	0.34
Styler group	n = 13	n = 16	
Total time	27 ± 3	33 ± 8	0.013
P (between total time)	0.09	0.8	

Mean ± standard deviation. T1 = time from removal of the face mask to insertion of a gum elastic bougie into the trachea; T2 = time from insertion of the gum elastic bougie to confirming successful tracheal intubation by capnogram; Total time = time from removal of the face mask to confirming successful tracheal intubation; Easy = grade 1, 2a; Restricted = grade 2b, 3a of Cook's modified laryngeal classification.

the same in 26 of 60 patients (43.3%), worsened one grade in 17 of 60 patients (28.3%), and worsened two grades in 14 of 60 (23.3%) patients. The view of the larynx improved in the remaining three patients (5.0%). Statistically, the view of the larynx worsened when cricoid pressure was applied ($P < 0.05$, Chi squared test).

Failed tracheal intubation

In 58 patients, tracheal intubation was successful at the first attempt; in the remaining two patients with a 3b laryngeal view, tracheal intubation failed according to study protocol. They were excluded from the study. Intubation was successful using another device.

Duration and ease of tracheal intubation

The times taken for intubation are shown in Table III. When a bougie was used, there were no statistical differences in T1, T2 and total time for intubation between the 'easy' and 'restricted' groups. When a styler was used, the duration of intubation in the patients with a 'restricted' view was six seconds longer than that of 'easy' patients, although the difference is clinically trivial.

The mean VAS was significantly greater in the styler restricted group than in the other three groups ($P < 0.01$). There were no statistical differences between the bougie easy, bougie restricted groups and styler easy group (Figure).

Discussion

In the present study, we observed that: 1) applying cricoid pressure worsens the view of the larynx; 2) in the 'restricted' groups, the difficulty of tracheal intubation is significantly greater when using a styler com-

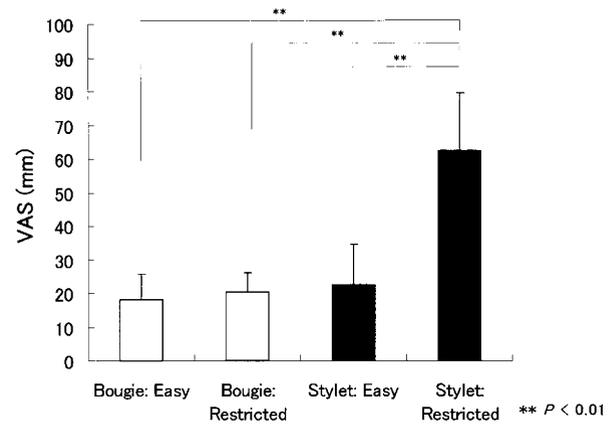


FIGURE Visual analogue scale (VAS) for the ease of tracheal intubation during application of cricoid pressure. Patients were grouped by laryngeal view ('easy' or 'restricted') and aid for tracheal intubation (gum elastic bougie or styler). ** $P < 0.01$

pared to a bougie; 3) in the two patients with grade 3b laryngeal view, the trachea could not be intubated even with the help of these devices. Our results show the superiority of a gum elastic bougie to a styler for tracheal intubation during application of cricoid pressure.

It has been shown that applying cricoid pressure causes anatomical distortion of the upper airway and makes airway management more difficult.^{1,2} The application of cricoid pressure may interfere with laryngoscope blade placement.⁴ Furthermore, external laryngeal pressure to improve the view of the larynx may not be performed concurrently with cricoid pressure.⁴ Conventionally, Cormack and Lehane's classification¹⁸ is used to assess the view of the larynx. Cook¹³ demonstrated that a new classification is as sensitive and more specific in predicting difficult intubation. We confirmed that applying cricoid pressure worsens the view of the larynx.¹³ According to a previous review, the incidence of Cormack and Lehane classification grade 3/4 ranges from 1.5 to 8.5%.¹⁹ In our study we observed 10% grade 3 (including 3a and 3b) laryngoscopies, but with a sample size of only 60 patients the 95% confidence interval for a true incidence extends from 2.4 to 17.5%,²⁰ an incidence similar to previous reports.

We aimed to compare a malleable metal styler with a gum elastic bougie to facilitate intubation during a simulated rapid sequence induction and cricoid pressure. It has been advocated that when speed of intubation is important, the tracheal tube should always be styled.⁷

In our study, when the view of the larynx was 'easy', the duration of tracheal intubation with a stylet was always short. When the patient had a 'restricted' view of the larynx, the duration of tracheal intubation with a stylet was prolonged and intubation was significantly more difficult. In contrast, when a gum elastic bougie was used, there were no marked differences between the 'easy' and the 'restricted' groups. These findings are consistent with Cook's report.¹³

Both a stylet and a gum elastic bougie are simple adjuncts for tracheal intubation. However, they are different in several aspects. A gum elastic bougie is a 60-cm long device composed of two layers: a core of tube woven from Dacron polyester threads and an outer resin layer to provide stiffness; flexibility; and a slippery, water impervious surface.²¹ A stylet is made of various types of metal and has little flexibility. The stylet is rigid and often acutely angled. Consequently, it is often difficult to manipulate the tube and stylet away from the anterior wall of the larynx and into the trachea.⁸ In addition, protruding of the stylet through the bevel of the tube is a serious hazard to the larynx and tracheal wall.²²

When tracheal intubation is attempted with a stylet in patients in whom the glottis and vocal cords are not visible, it is often difficult to distinguish successful tracheal intubation from accidental esophageal intubation.²³ In contrast, a bougie can be advanced blindly towards the vocal cords and successful tracheal placement is confirmed by both 'click' and 'distal hold up' sensations,¹⁴ and whenever the bougie was confirmed to be in the trachea, the tracheal tube did not fail to follow.¹⁰

There are several potential limitations of our study with respect to experimental design. First, the person applying cricoid pressure was not blinded to the techniques the investigator used. We attempted to standardize the pressure exerted by using a set of weighting scales at all times. Second, the success rate and duration of intubation were not clinically different between the stylet and the bougie group. The only difference was seen in the VAS scores assessed by a single investigator. Although the investigator had experienced both methods in over 300 cases, the possibility of bias and lack of generalizability remain and further evaluation would be appropriate.

Lastly, two patients with grade 3b ('difficult') laryngeal view, the trachea could not be intubated according to study protocol. In clinical practice, if difficult intubation is predicted preoperatively, fiberoptic intubation or other sophisticated methods can be used by a well-trained anesthesiologist.²⁴ However, up to 50% of cases of difficult intubation occur without any

preoperative sign⁵ but, also, cricoid pressure itself makes tracheal intubation more difficult. Based on our findings, in case of a grade 3a view of the larynx, using a gum elastic bougie is an easier method for tracheal intubation even when cricoid pressure is applied.

In summary, applying cricoid pressure made tracheal intubation more difficult. Both stylet and gum elastic bougie are effective when used in patients during cricoid pressure. However, using the gum elastic bougie is an easier method for successful tracheal intubation.

References

- 1 *Rosen M.* Anaesthesia for obstetrics (Editorial). *Anaesthesia* 1981; 36: 145–6.
- 2 *Crawford JS.* The 'contracricoid' cuboid aid to tracheal intubation (Letter). *Anaesthesia* 1982; 37: 345.
- 3 *Vanner RG, Asai T.* Safe use of cricoid pressure (Editorial). *Anaesthesia* 1999; 54: 1–3.
- 4 *Brimacombe JR, Berry AM.* Cricoid pressure. *Can J Anaesth* 1997; 44: 414–25.
- 5 *Wilson ME.* Predicting difficult intubation (Editorial). *Br J Anaesth* 1993; 71: 333–4.
- 6 *Melker RJ.* Airway devices and their application. *In:* Kirby RR, Gravenstein N, Lobato EB, Gravenstein JS (Eds.). *Clinical Anesthesia Practice*, 2nd ed. Philadelphia: W.B. Saunders Co.; 2001: 303–28.
- 7 *McCarroll SM, Lamont BJ, Buckland MR, Yates APB.* The gum-elastic bougie: old but still useful (Letter). *Anesthesiology* 1988; 68: 643–4.
- 8 *Morris J, Cook TM.* Rapid sequence induction: a national survey of practice. *Anaesthesia* 2001; 56: 1090–7.
- 9 *Latto IP, Stacey M, Mecklenburgh J, Vaughan RS.* Survey of the use of the gum elastic bougie in clinical practice. *Anaesthesia* 2002; 57: 379–84.
- 10 *Gataure PS, Vaughan RS, Latto IP.* Simulated difficult intubation. Comparison of the gum elastic bougie and the stylet. *Anaesthesia* 1996; 51: 935–8.
- 11 *Nolan JP, Wilson ME.* Orotracheal intubation in patients with potential cervical spine injuries. An indication for the gum elastic bougie. *Anaesthesia* 1993; 48: 630–3.
- 12 *Mallampati SR, Gatt SP, Gugino LD, et al.* A clinical sign to predict difficult tracheal intubation: a prospective study. *Can Anaesth Soc J* 1985; 32: 429–34.
- 13 *Cook TM.* A new practical classification of laryngeal view. *Anaesthesia* 2000; 55: 274–9.
- 14 *Kidd JF, Dyson A, Latto IP.* Successful difficult intubation. Use of the gum elastic bougie. *Anaesthesia* 1988; 43: 437–8.
- 15 *Dogra S, Falconer R, Latto IP.* Successful difficult intubation. Tracheal tube placement over a gum-elastic bougie. *Anaesthesia* 1990; 45: 774–6.
- 16 *Ovassapian A, Meyer RM.* Airway management. *In:* Longnecker DE, Murphy FL (Eds.). *Dripps*,

- Eckenhoff, Vandam Introduction To Anesthesia, 9th ed. Philadelphia: W.B. Saunders Co.; 1996: 137–58.
- 17 *Asai T, Murao K, Tsutsumi T, Shingu K.* Ease of tracheal intubation through the intubating laryngeal mask during manual in-line head and neck stabilisation. *Anaesthesia* 2000; 55: 82–5.
 - 18 *Cormack RS, Lehane J.* Difficult tracheal intubation in obstetrics. *Anaesthesia* 1984; 39: 1105–11.
 - 19 *Crosby ET, Cooper RM, Douglas MJ, et al.* The unanticipated difficult airway with recommendations for management. *Can J Anaesth* 1998; 45: 757–76.
 - 20 *Daly LE, Bourke GJ, McGilvray J.* Interpretation and Uses of Medical Statistics, 4th ed. London: Blackwell Scientific; 1988.
 - 21 *Viswanathan S, Campbell C, Wood DG, Riopelle JM, Naraghi M.* The Eschmann tracheal tube introducer (gum elastic bougie). *Anesthesiol Rev* 1992; 19: 29–34.
 - 22 *Harmer M.* Complications of tracheal intubation. *In:* Latta IP, Vaughan RS (Eds.). *Difficulties in Tracheal Intubation*, 2nd ed. Philadelphia: W.B. Saunders Co.; 1996: 291–306.
 - 23 *Stasiuk RBP.* Improving styletted oral tracheal intubation: rational use of the OTSU. *Can J Anesth* 2001; 48: 911–8.
 - 24 *Weiss M, Hartmann K, Fischer J, Gerber AC.* Video-intuboscopic assistance is a useful aid to tracheal intubation in pediatric patients. *Can J Anesth* 2001; 48: 691–6.