Cricoid pressure decreases ease of tracheal intubation using fibreoptic laryngoscopy (WuScope System™)

[La compression cricoïdienne rend l'intubation endotrachéale moins facile à l'aide de la laryngoscopie fibroscopique (WuScope System™)]

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Purpose: Cricoid pressure is commonly used during rapid sequence induction and intubation to minimize the risk of aspiration. The objective of the study was to evaluate the ease of fibre-optic (WuScope System™) intubation in anesthetized adults receiving cricoid pressure.

Methods: The intubation difficulty scale (IDS) was used to measure tracheal intubation difficulties in 33 patients undergoing elective surgery with general anesthesia and complete neuromuscular blockade. Each patient had their trachea intubated under two conditions: with and without cricoid pressure. The order of conditions was determined randomly. Cricoid pressure was applied by an experienced anesthesia provider.

Main results: An IDS value of 0 (ideal intubation, that is one performed by the first operator on the first attempt, using the first technique with full visualization of the glottis and no vocal cord compression) occurred in 30 of 33 patients (91%) without cricoid pressure and in 22 of 33 patients (67%) with cricoid pressure ($P < 0.05$). Cricoid pressure compressed the vocal cords in nine patients (27%) and impeded tracheal tube placement in five (15%). In three patients (9%), pressure had to be released in order to successfully intubate.

Conclusion: Cricoid pressure may impede or even prevent fibre-optic laryngoscopic intubation with the WuScope System™.

Objectif : La compression cricoïdienne est couramment utilisée pendant la séquence rapide d'induction et d'intubation afin de réduire le risque d'aspiration. L'objectif de l'étude était d'évaluer la facilité de l'intubation fibroscopique (WuScope System™) chez des adultes anesthésiés subissant une compression cricoïdienne.

Méthode : L'échelle des difficultés d'intubation (EDI) a été utilisée pour 33 patients subissant une intervention chirurgicale non urgente sous anesthésie générale et blocage neuromusculaire complet. L'intubation de chaque patient s'est faite dans deux conditions : avec et sans compression cricoïdienne dont l'ordre était déterminé de façon aléatoire. La compression cricoïdienne était appliquée par une personne expérimentée en anesthésie.

Résultats : Une valeur de 0 à l'EDI (intubation idéale, réussie par le premier utilisateur au premier essai en utilisant la première technique sous complète visualisation de la glotte et sans compression des cordes vocales) a été enregistrée pour 30 des 33 patients (91 %) sans compression cricoïdienne et pour 22 des 33 patients (67 %) avec compression cricoïdienne ($P < 0,05$). La pression sur le cricoïde a comprimé les cordes vocales chez neuf patients (27 %) et gêné la mise en place du tube endotrachéal chez cinq d'entre eux (15 %). Il a fallu relâcher la pression chez trois patients (9 %) afin de réussir l'intubation.

Conclusion : La compression cricoïdienne peut gêner ou même empêcher l'intubation laryngoscopique fibroscopique avec le WuScope System™.

CRICOID pressure is used to control regurgitation of gastric or esophageal contents until endotracheal intubation with a cuffed tube is completed.¹ Although cricoid pressure has become widely accepted as a practice standard to minimize the risk of pulmonary aspiration during rapid sequence induction and intubation (RSI), application of cricoid pressure may produce airway

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obstruction at the level of the cricoid cartilage or vocal cords, and interfere with tracheal intubation.²⁻⁴ For example, in a randomized study of lightwand-assisted tracheal intubation with and without cricoid pressure in adults, time to successful intubation was prolonged and the failure rate for the first attempt at intubation was increased in the cricoid pressure group.⁵ Similarly, in a double-blind randomized study of fibroscope-aided tracheal intubation through the laryngeal mask airway (LMA) with and without cricoid pressure in adults, it was impossible to intubate the trachea in 85% of the cricoid pressure group.⁶

The WuScope System™ (WSS; Pentax Precision Instruments, Orangeburg, NY, USA) is a fiberoptic intubating device, combining rigid laryngoscope blades with a flexible fibroscope.^{7,A} Since fiberoptic laryngoscopy with the WSS allows visualization of the larynx and intubation of the trachea without head or neck movement, it has been shown to be an effective method for tracheal intubation of trauma patients with known or potential cervical spine injuries.^{8,9} However, it has been our clinical impression that application of cricoid pressure can interfere with WSS intubation.

The purpose of this randomized, prospective study was to assess the effect of cricoid pressure on the ease and time for successful intubation using the WSS fiberoptic laryngoscope. Tracheal intubation difficulties were quantified using the intubation difficulty scale (IDS) score.¹⁰

Methods

The study was approved by the MetroHealth Medical Center Institutional Review Board and written informed consent was obtained from the patients. Thirty three adults, ASA physical status I–III undergoing elective surgery requiring general anesthesia, neuromuscular blockade and tracheal intubation were studied prospectively. Patients were excluded if they had a history of difficult intubation, Mallampati class 3 or 4 airway, thyromental distance < 6.5 cm, mouth opening < 3.5 cm, cervical spine disease, other factors predictive of intubation difficulty such as anteriorly protruding incisors, and risk factors for aspiration. Each patient had their trachea intubated under two conditions by a single investigator (CES): with and without cricoid pressure. The order of conditions was determined by a table of random numbers.

Premedication was with midazolam, 1–2 mg, *iv*. Monitoring consisted of electrocardiogram, pulse oximeter, capnography, and noninvasive blood pressure measurement. The patient breathed 100% oxygen prior to induction. Anesthesia was induced with fentanyl, 1–2 $\mu\text{g}\cdot\text{kg}^{-1}$, and propofol 2–2.5 $\text{mg}\cdot\text{kg}^{-1}$ or thiopental, 3–5 $\text{mg}\cdot\text{kg}^{-1}$, until loss of the eyelash reflex. Neuromuscular blockade was with rocuronium, 0.6–1.0 $\text{mg}\cdot\text{kg}^{-1}$, or cisatracurium, 0.2 $\text{mg}\cdot\text{kg}^{-1}$. The patient's lungs were ventilated manually with 100% oxygen and isoflurane (0.6–1%, inspired concentration). After onset of complete neuromuscular blockade, as evidenced by visual loss of all four orbicularis oculi twitches in response to train-of-four supramaximal stimulation of the facial nerve,¹¹ the patient's head and neck was placed in the neutral position without a pillow. Cricoid pressure was applied by an experienced anesthesia provider (anesthesia resident, anesthesia assistant, CRNA) using a single handed technique. The thumb and middle finger were placed on either side of the cricoid cartilage and cricoid pressure was applied by the index finger.^{1,3} During the control condition (no cricoid pressure) the anesthesia provider placed their thumb, middle and index finger in the same manner without applying any pressure. The intubator was unaware of the condition being applied.

Fiberoptic laryngoscopy was done as follows: the rigid blade was introduced into the patient's mouth at the midline and the handle was rotated towards the operator and the main blade advanced until the epiglottis and larynx came into view. A prewarmed cuffed endotracheal tube (ETT), size 8.0 mm internal diameter for males and size 7.0 internal diameter for females, was then advanced through the glottis and into the trachea (Mallinckrodt Medical, St. Louis, MO, USA). A suction catheter inside the ETT was used to remove secretions. The intubation process was viewed on a colour video monitor using a camera connector with focusing ring that attached to the fibroscope. A fiberoptic light source was used to provide illumination. Large adult blades were used for males > 70 kg and small adult blades were used for females and smaller males. Following the first intubation, the ETT was removed and the trachea was intubated a second time, under the complementary condition. The patient's lungs were ventilated with 100% oxygen and isoflurane between intubation attempts. If the trachea could not be intubated during the assigned condition, the anesthesia provider was instructed to withdraw his/her hand from the cricoid cartilage.

Tracheal intubation difficulty was determined for each condition using the IDS score which consists of seven parameters of intubation difficulty:¹⁰ N₁–the

^A The WuScope System™. Achi Online. Product Overview. <http://www.achi.com/htm/jvwhat1s.htm#what1s>. Accessed January 18, 2002.

TABLE I Patient characteristics ($n = 33$)

Age (yr)	41 $\pm$ 14
Gender (M/F)	9/24
Weight (kg)	77 $\pm$ 17
Height (cm)	165 $\pm$ 10
ASA physical status I–III	3/25/5
<i>Type of surgery</i>	
- General	9 (27)
- Orthopedics	11 (33)
- Gynecology	11 (33)
- Other	2 (6)

Data are means $\pm$ SD or number of patients (percentage).

TABLE II Time to tracheal intubation using fiberoptic laryngoscopy and reasons for intubation difficulty scale score (IDS) ≥ 1

	<i>Cricoid pressure</i>	<i>Control</i>
<i>Time to intubation (mean $\pm$ SD, sec)</i>	33 $\pm$ 16	32 $\pm$ 42
25 th –75 th percentile	22–40	14–32
Range	11–72	9–250
<i>Reasons for IDS ≥ 1</i>		
<i>[number of patients (%)]</i>		
Vocal cord compression	9 (27%)	0
Large tongue	1 (3%)	1 (3%)
External laryngeal pressure	0	1 (3%)
Grade 2 view	2 (6%)	0
Grade 3 view	1 (3%)	0
Separation of Wu extender and handle	0	1 (3%)
Change technique (release cricoid pressure)	3 (9%)	0

There could be more than one reason for intubation difficulty. Time to intubation was similar between groups.

number of supplementary intubation attempts. An attempt was defined as the entire process of inserting and removing the blade from the patient's mouth; N_2 -the number of supplementary operators; N_3 -the number of alternative intubation techniques used. Release of cricoid pressure was considered a change in technique; N_4 -glottic exposure as defined by the Cormack grade minus one (grade 1 = complete visualization of the vocal cords, grade 2 = visualization of the inferior portion of the glottis, grade 3 = visualization of only the epiglottis, and grade 4 = non-visualized epiglottis). Glottic exposure was evaluated during the first attempt for each condition; N_5 -the lifting force applied during laryngoscopy ($N_5 = 0$ if little effort was necessary, and $N_5 = 1$ if subjectively increased lifting force was used); N_6 - the necessity of applied external laryngeal pressure for improved glottic exposure ($N_6 = 0$ if no external pressure was applied and $N_6 = 1$ if external laryngeal pressure was necessary; application of cricoid pressure did not affect N_6); N_7 - position of the vocal cords at intubation (N_7

$= 0$ if the vocal cords were in abduction. $N_7 = 1$ if the cords were adducted or compressed blocking the tube passage). If the cords were not visualized, $N_7 = 0$. The IDS score was the sum of N_1 – N_7 .

This scoring system quantifies the progressive intubation difficulty. The score ranges from 0 (intubation without any difficulty) to a theoretically unlimited value, corresponding to the maximum difficulty met before success or abandonment of the procedure. An intubation of "no difficulty" or "ideal conditions" is defined when the tube is inserted into the fully visualized larynx, with little effort, on the first attempt (IDS = 0). With increasing difficulty the head may be repositioned, there may be more than one attempt at intubation, different laryngoscope blades may be employed, external laryngeal pressure may be applied, and more than one intubator may be involved.¹⁰ The IDS value is dependent on these variables and its value increases in relation to all efforts necessary to successfully complete the intubation.

Time to intubation was from the moment the blade touched the patient until visualizing the ETT through the glottis opening. In the case of incomplete glottic visualization, duration extended until a successful intubation was performed as confirmed by sustained presence of end-tidal CO_2 on the capnogram.

Statistical analysis

The hypotheses tested were that, compared with the control condition, ideal intubation would occur less frequently and time to intubation would be longer with cricoid pressure. For power analysis calculations, an IDS value of 0 (ideal intubation) was predicted to occur in 80% of intubations without cricoid pressure, and in 40% of intubations with cricoid pressure. With a sample size of 33 patients, the power of detecting this difference between intubating conditions was 0.9 at an alpha of 0.05. Cochran-Mantel-Haenszel Statistics, Repeated Measures Model, was used for IDS comparisons. Paired t test was used for time to intubation comparison. A P value < 0.05 was considered statistically significant.

Results

Patient data are summarized in Table I. Application of cricoid pressure as the first technique was done in 17 patients, whereas 16 patients had no cricoid pressure as the first technique. An IDS value of 0 occurred in 30 of 33 patients (91%) without cricoid pressure and in 22 of 33 patients (67%) with cricoid pressure ($P < 0.05$, Cochran-Mantel-Haenszel Statistics, Repeated Measures Model, Figure). No trauma to the lips or teeth was noted. Time to intubate the trachea was

FIGURE Frequency histogram of the distribution of the intubation difficulty scale scores (IDS) using fibreoptic laryngoscopy in 33 patients with and without application of cricoid pressure. $P < 0.05$ between groups (Cochran- Mantel-Haenszel test).

similar between groups (paired *t* test, $P = 0.89$, Table II). Cricoid pressure compressed the vocal cords in nine patients (27%) and impeded ETT placement in five (15%). In three patients (9%), pressure had to be released in order to intubate successfully.

Discussion

The WSS has been used to facilitate tracheal intubation, especially in patients who require cervical spine immobilization because the oropharyngeal airway shaped blade and modified handle to blade angle allows glottic visualization and intubation without the need for head extension.⁷⁻⁹ Another advantage of the WSS is that it allows for continuous viewing of the ETT as it advances through the glottic opening into the trachea. The study demonstrated that single handed cricoid pressure without a pillow or head extension increased tracheal intubation difficulty with the WSS, and made it impossible to intubate the trachea in 9% of patients. Failed intubation was due to compression of the vocal cords by the cricoid pressure. Vocal cord compression was not observed during the control condition, and was promptly relieved after release of cricoid pressure allowing for intubation in all instances.

Single handed and bimanual cricoid pressure have previously been shown to interfere with fibreoptic intubation. For example, in anesthetized patients undergoing single handed cricoid pressure, inline neck stabilization and flexible fibreoptic bronchoscopy, the larynx could not be visualized in ten of 25 patients (40%).¹² Of the 15 patients having successful laryngo-

scopic view, cricoid pressure prevented advancement of the ETT into the trachea in two (13%).¹² In a randomized, blinded study of airway patency in anesthetized, paralyzed patients, application of single handed cricoid pressure not only caused reductions in expired tidal volume and increased peak inspiratory pressure during manual bag-mask ventilation, but resulted in complete airway occlusion in 6% of patients.¹³ The author suggested that loss of airway patency was likely from obstruction at the level of the vocal cords,¹² a finding supported by the present study. Bimanual cricoid pressure has also been shown to interfere with flexible fibreoptic intubation via the LMA because of glottic distortion and deviation,^{6,14} and because of incorrect positioning of the LMA.⁶ Intubation failure rates were 85% when the cricoid pressure was applied before LMA insertion,⁶ and 40% when cricoid pressure was applied after LMA insertion.¹⁴

High intubation failure rates (e.g., 80%) have also been reported with the intubating LMA in patients wearing a semi-rigid neck collar and with single handed cricoid pressure,¹⁵ likely due to the combination of restricted mouth opening from the collar together with glottic distortion from the cricoid pressure. In another study using the intubating LMA without the semi-rigid neck collar, tracheal intubation was successful in 21 (84%) of the non-cricoid group and 13 (52%) of the cricoid group.¹⁶

In contrast, single-handed cricoid pressure did not interfere with tracheal intubation using the Bullard laryngoscope in elective patients with cervical immobilization.¹² In the study,¹² time to successful intubation with the Bullard was 37–38 sec, which is slightly longer than the 31–33 sec observed in the present study.

It is recognized that the force required to prevent regurgitation of stomach contents depends on the efficacy with which the cricoid pressure is transmitted to the esophageal lumen and the esophageal pressure. In the present study, different anesthesia providers applied the cricoid pressure using the single-handed method described by Sellick.¹ Although these individuals were all skilled in the application of cricoid pressure, it is possible that some instances of vocal cord compression and difficult fibreoptic intubation may have been due to use of excessive force with subsequent anatomical distortion of the airway. The use of different anesthesia providers is, however, consistent with the clinical setting where cricoid force may vary.^{5,17}

It is likely that the optimum cricoid force to generate an occlusive esophageal pressure in excess of intragastric pressure in the paralyzed patient lies between 20 N and 30 N.¹⁷ There is a need for simple instruction and use of training models to aid the acquisition

and maintenance of cricoid pressure technique, since it has been shown that a significant proportion of anesthetic assistants in the United Kingdom applied cricoid forces that greatly exceeded 44 N.¹⁷

Single handed cricoid pressure is usually preferred in patients with possible cervical spine problems because it is unlikely to cause clinically significant displacement of the cervical spine.¹⁸ The technique of cricoid pressure (single-handed *vs* bimanual) which produces the best glottic view using conventional laryngoscopy in an individual patient cannot be predicted.^{19,20}

Although manual in-line neck immobilization was not done in the present study, the patients' head and neck were kept in the neutral position without head extension or use of the sniffing position. Despite this altered positioning, ideal fiberoptic WSS intubations (IDS = 0) occurred in the majority of patients without cricoid pressure as previously described in patients with cervical spine immobilization.⁹

The IDS score has been used previously to assess the complexity of fiberoptic WSS intubation in patients with normal and abnormal airway anatomy.⁸ This score is based on seven parameters known to be associated with intubation difficulty and varies by whole numbers. Although an IDS > 5 is consistent with an intubation of moderate to major difficulty,¹⁰ it is recognized that there is no real border between the "difficult intubation" and the "not difficult intubation," but rather a spectrum of difficulty, from easy to impossible. Thus, an IDS value that differs from 0 (e.g., IDS values of 1, 2, or 3), quantitatively reflects the divergence from an ideal intubation even though the IDS value might not be correlated with a longer time of intubation or a lower success rate. The advantage of this scoring system is that it evaluates all degrees of difficulty. As such, the IDS is a quantitative measure of the total intubation difficulty during a chosen sequence of intubation procedures, and is very useful for comparing intubation techniques in populations of patients who are the same in all respects except for the variable being studied. However, the total score does not identify the reason for intubation complexity. Therefore, one must also examine the individual variables that make up the score and the reasons for increased intubation difficulty. In the present study, it is obvious that vocal cord compression was the major factor in increasing the IDS score, although technical problems with the WSS (e.g., separation of the handle and extender) and with patient anatomy (e.g., large tongue) can still result in increased intubation difficulty.

Based on previous clinical observations and the results of the present study, it is concluded that cricoid

pressure may impede or even prevent fiberoptic laryngoscopic intubation with the WSS.

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