AN ALGORITHM FOR EASY INTUBATION. COMBINED USE OF THE MACINTOSH LARYNGOSCOPE AND FLEXIBLE BRONCHOSCOPE IN UNEXPECTED DIFFICULT INTUBATION

FRANCESCO SGALAMBRO*, ANGELO DENARO*, MARIO GUGLIELMO*, MARIA TIZIANA SANTONOCITO*, CHIARA MARIA CELESTRE**, CATERINA MARIA GRILLO***, LUIGI MAIOLINO***, CALOGERO GRILLO***
*Department Anaesthesia and Intensive Care Oncology Institute of the Mediterranee Viagrande -Catania - **School of Anesthesiology and Intensive Care -University Catania - ***Department ENT- University Catania

[Algoritmo per una intubazione sicura. Uso combinato del laringoscopio di Macintosh e del broncoscopio flessibile nelle difficoltà di intubazione inaspettate]

ABSTRACT

Background. *We evaluated the efficacy, safety, and learning curve for the combined use of the MacIntosh laryngoscope and flexible bronchoscope under general anesthesia with muscle relaxation. We also evaluated the effectiveness of an algorithm for injury-free intubation.*

Methods. *For standardization and training, from 2010–2011 we enrolled 314 patients >18 years of age who were undergoing non-emergency oncologic, thyroid, urological, otolaryngological, or spinal column surgery. A total of 2143 intubations were performed based on an algorithm that was able to predict direct passage from traditional methods to a combined technique and that prevented any predicted difficult intubation after laryngoscopy.*

Results. *All patients were treated successfully with the combined technique. In 253 patients (80.5%), intubation was accomplished within 1 minute; in 53 patients (16.8%), within 3 minutes; and in 8 patients (2.5%), longer than 3 minutes. SaO_2 was maintained at 95-100%. On average, 10 procedures were needed for novice operators to attain proficiency in the technique. In the algorithm group, 2092 procedures were performed using the traditional technique and 51 (Cormak-Lehane III-IV Laringoscopy) using the combined technique without injury or bleeding.*

Conclusions. *We obtained optimal results with the combined method, which was quickly learned by others. The algorithm described herein allows for safe intubation without injuries. Because of its simplicity and low cost, this combined approach could become a common solution for unexpected difficult intubations under general anesthesia with muscle relaxation.*

Key words: *Intubation, difficult airway, flexible bronchoscope, macintosh laryngoscope, combined technique.*

Received *May 29, 2013;* ***Accepted*** *June 18, 2013*

Introduction

Within the field of airway management for anesthesia and critical care medicine, several authors have reported interesting comparisons among the different techniques used to perform rapid and safe intubation for routine approaches or unexpected difficulties. The recent literature focuses on the role of evidence-based medicine in terms of solutions for problems associated with tracheal intubation. The essential message from these authors is that the entire intubation procedure requires visualization of the vocal cords and that the endotracheal tube should be introduced under visual control[5].

The entire procedure for tracheal intubation under general anesthesia should be carried out under visual control to limit the risks. In recent years, many devices[1,2,6,7,10] have been developed that allow laryngeal visualization, but these are limited to only the first stage of the procedure, i.e., visualization of the glottis. The second phase, insertion of the endotracheal tube, is sometimes performed with difficulty, which is associated with the danger of trauma with bleeding[9]. The only instrument that provides full visualization throughout intubation and easy entry in trachea is the flexible bronchoscope.

The scientific community considers the fiberoptic bronchoscope to be the most reliable tool for patients with difficult airways, but experience and skill are required for its use[5].

In our oncologic institute, we often encounter patients who have cancers located in the head and neck regions, necessitating the use of a flexible bronchoscope. Thus, we have codified and standardized an intubation technique that uses a flexible bronchoscope in combination with the MacIntosh laryngoscope under anesthesia with muscle relaxation.

Intubation using a flexible bronchoscope is performed with the patient awake or sedated because maximum muscle tone of the laryngeal structures facilitates passage of the instrument. Under conditions of anesthesia with muscle relaxation, insertion of a flexible bronchoscope is difficult. The MacIntosh laryngoscope acts as a lever, allowing for normal maneuvering of the bronchoscope under anesthesia. This technique has allowed successful intubation even in cases with laryngeal visualization of Cormack grade 4 and that are unclassifiable (Fig. 1).

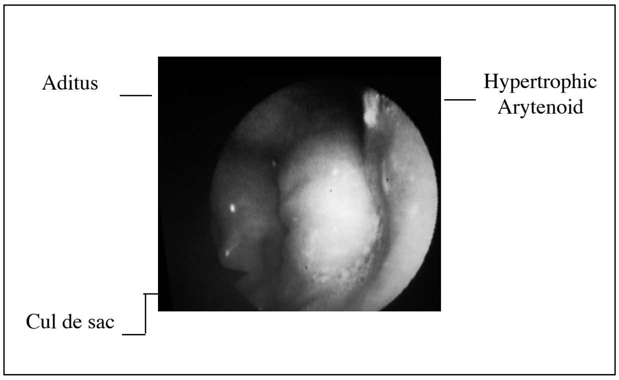

Figure 1: Cormack unclassifiable. Bowel obstruction in patients laryngectomee.

The ethics committee approved the standardization and training of the young anesthesiologists in this study in the use of the combined intubation technique .The procedure was performed successfully by experienced anesthesiologists in 200 surgical patients. We implemented a cooperative project with the Medical School of Anesthesiology in Catania to train the students under tutor guidance. The results are based on a total of 314 procedures involving surgery of the neck, abdomen, breast, and spinal cord. Easy intubation was achieved in 2143 patients using an algorithm that was able to predict direct passage from traditional methods to a combined technique and that prevented any predicted difficult intubation after laryngoscopy.

Materials and methods

From 2010–2011, we performed 2143 intubations in patients of both genders who were >18 years of age and who were not likely to require emergency surgery. A total of 314 intubations were performed using the combined technique for standardization, training and algorithm application (Table 1).

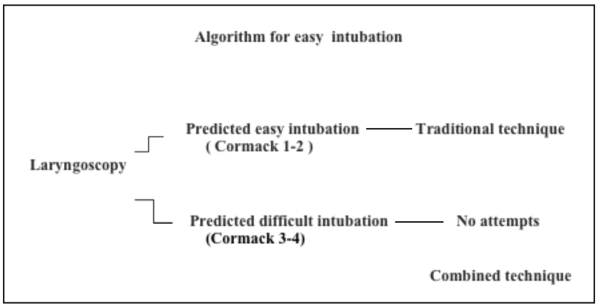

Table 1: Algorithm.

In the combined technique group, 200 procedures were performed by experienced anesthetists to standardize the method and apply the algorithm, and 114 procedures were performed by operators in training.

The primary outcome was the success of intubation with the combined technique and a learning curve within 20 procedures. The secondary end point was easy intubation without injury or bleeding using the algorithm.

The instrumentation used was a MacIntosh laryngoscope with a curved blade and a flexible bronchoscope (diameter, 5.6 mm; length, 54 cm) with suction channels.

Visualization was classified according to the Cormack-Lehane scale. To enable standardization and training, the combined method was also used in this study in cases of Cormack grades 1-2. The treatment algorithm approved the use of the combined method in cases of Cormack grades 3 and above. The protocol in cases experiencing difficulty with facemask ventilation was to use a laryngeal mask.

The combined method was considered to have failed when intubation was unsuccessful in the awake patient. The degree of difficulty was assessed by the Cormack-Lehane index and the intubation time, measured from the end of 3 minutes of ventilation with 100% O_2 after administration of a muscle relaxant.

The time was classified as 1 through 3 according to difficulty score (Table 2).

Difficulty Score (Procedure Time)
1 (within 1 min.)
2 (within 3 min.)
3 (up 3 min.)

Table 2: Execution time

Operators were trained in two phases: first, with 30 min of instruction on the manual use of a bronchoscope, with indications for maneuvers to facilitate performance; and second, with video-guided execution of the maneuvers. A total of 10 operators were trained: 5 students at the School of Anesthesia and 5 senior anesthetists. The learning curve was evaluated on the basis of the number of interventions by tutors during execution of the procedure.

The protocol was as follows. The patient was positioned in the 'sniffing' position, and standard induction of anesthesia was achieved using midazolam 0.03 mg/kg and fentanyl 0.7 gamma/kg, followed by propofol at 2 mg/kg after 2 min. To verify ventilability, atracurium was administered at 0.6 mg/kg for muscle relaxation and ventilation with 100% O_2 for 3 min. The execution time was calculated from the end of mask ventilation. Using the MacIntosh laryngoscope, laryngeal visualization in each case was classified according to the Cormack scale, after which the bronchoscope was introduced into the trachea (Figs. 2-3-4).

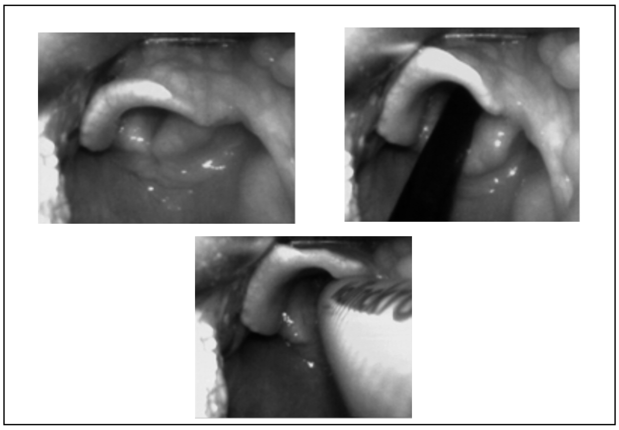

Fig. 2: Laryngoscopy
Fig. 3: Bronchoscope introduction
Fig. 4: Tracheal tube introduction

Technique

The operator was positioned at the head of the patient, as in a normal intubation. First, the operator performed laryngoscopy by inserting the laryngoscope to provide maximum visualization (Fig. 2). While an assistant held the instrument in this position, the operator introduced the bronchoscope along the blade of the MacIntosh laryngoscope (Fig. 3), stopping at the lower third of the trachea when the carina came into view. The operator then slid the endotracheal tube through the bronchoscope and positioned it in the trachea under visual control (Fig. 4).

Statistical analyses

Two groups were used for the statistical analysis. The first included all patients in whom both the traditional technique and combined technique was used, and the success of the procedure and traumatic injuries were evaluated. The second included patients in whom intubation was performed with the combined technique and the following parameters were evaluated: Cormack-Lehane index, execution time, scale of difficulty, SaO_2, success, traumatic injuries, and learning curve. Descriptive statistics including frequency counts, percentage proportions, and mean and SD calculations were computed (Microsoft Excel 97-2003 Worksheet).

Results

Table 3 summarizes the results of the combined technique. The average age of the patients was 58.13 years. As shown in Table 5, the Cormack-Lehane grades were CL1 (57.3%), CL2 (26.4%), CL3 (13.4%), and CL4 (2.9%). In 253 patients (80.5%), intubation was accomplished within 1 min; in 53 (16.8%), within 3 min; and in 8 (2.5%), in longer than 3 min (Table 6). The SaO_2 was maintained at 95-100% in all cases, and all patients were treated successfully with no injuries.

In the algorithm group, intubations were attempted using the traditional technique A total of 51 (2.37%) were not completed successfully and required the combined technique. No traumatic injuries or bleeding occurred. (Table 4)

The learning curve for proficiency in the method was rapid. Students at the School of Specialization for Anesthesiologists became proficient in the combined method after 8 procedures,

Cases	Success	Failure	Traumatic Injuries	Percentage Success	Percentage Failures	SaO_2 95-100%	Percentage SaO_2 95–100%
314	314	0	0	100	0	314	0

Table. 3: Result Combinated Tecnique - Total Cases.

	Cases	Success	Failure	Traumatic Injuries	Percentage Success	Percentage Failures	SaO_2 95-100%	Percentage SaO_2 95-100%
Traditional Technique	2143	2092	51	0	97,62	2,37	2140	100
Combined Technique	51	51	0	0	100	0	51	100

Table. 4: Result Algorithm Group.

		Frequency	Percentage	Percentage valid	Percentage cumulative
valid	1	180	57,3	57,3	57,3
	2	83	26,4	83,8	83,8
	3	42	13,4	13,4	97,1
	4	9	2,9	2,9	100,0
	total	314	100,0	100,0	

Table. 5: Cormak Lehane Index (ICL).

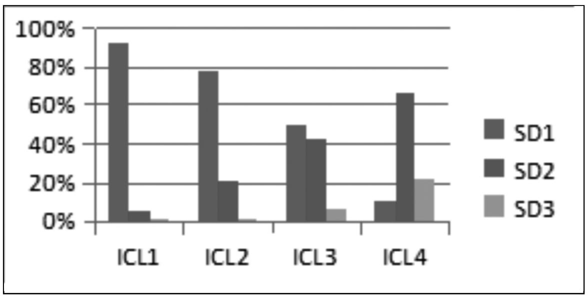

Fig. 5: Effectiveness of the combined technique.

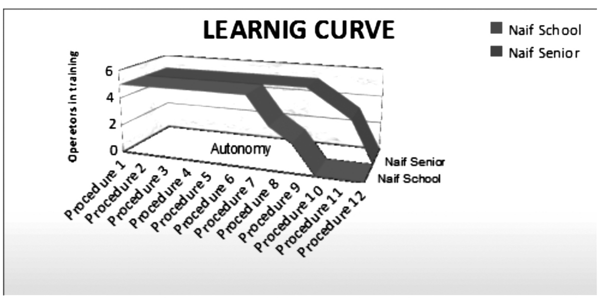

Fig. 6: Scale of difficulty (SD)-Cormack- Lehane Index (ICL).

with assistance from the tutor during the first 3. The anesthesiologists required more time to become proficient (12 procedures, with assistance from the tutor during the first 7) because they had to change their established approach (Fig. 6).

		Frequency	Percentage	Percentage valid	Percentage valid	Percentage cumulative
valid	1	253	80,6	80,6	80,6
	2	53	16,9	16,9	97,5
	3	8	2,5	2,5	100,0
	total	314	100,0	100,0	

Table. 6: Difficulty Score (SD).

The difficulty score includes the execution time in three degrees and allows for easy comparison of the times with the Cormack-Lehane index and measurement of the effectiveness of the technique (Fig. 5). This comparison may be useful as a reference for comparing different techniques.

Discussion

In the present study, the combined technique was used successfully in 100% of the patients, compared with a 97.6% success rate for the traditional technique. Success rates of 97-98% have been reported for the Glidescope and AirTraq (1,10) and 98.4% for the Bonfils[12]. The SaO2 was maintained at 95-100%. The proposed algorithm, which involved no attempts in cases of Cormack grades 3 and 4, allowed for intubation without injury or bleeding in 100% of patients. The risk of airway lesions in patients undergoing major surgery is about 1 in 500[9]. Routine use of this method will allow operators to become more familiar with the combined technique and to overcome difficult situations smoothly.

The achievement of the primary and secondary outcomes indicates that the combined method and algorithm allow for safe tracheal intubation in a short time, even in difficult anatomic situations. Coding and standardization of the combined method resulted in a rapid learning curve (10 procedures on average for a novice operator to reach proficiency), indicating easy execution and the possibility of use even by anesthesiologists inexperienced in broncoscopy.

One limitation of this study was the low representation of obese patients and obstetric patients. Additionally, the method was used by only one group of personnel. The technique is limited by the need for an assistant for its execution.

With this combined method, intubation difficulties due to anatomical structures can be foreseen and overcome without additional expense. Although the present results are encouraging, further studies must be performed by other teams with more patients and under various circumstances to confirm our results.

Conclusions

The combined technique described here allows the use of a flexible bronchoscope under narcosis with myoresolution to provide fully visualized tracheal intubation. Its coding and standardization has adapted the bronchoscopic technique to anesthesia practice and has reduced the execution time to nearly that of traditional techniques, and it can be quickly learned by novice operators. The proposed algorithm allows for intubation without injury or bleeding. This simple, low-cost, reliable, and safe technique may become a common solution for unexpected difficult intubations under general anesthesia with muscle relaxation.

References

1) Amathieu R, Combes X, et al: *An algorithm for difficult airway management, modified for modern optical devices (Airtraq Laryngoscope; LMA CTrach™): a 2-year prospective validation in patients for elective abdominal, gynecologic, and thyroid surgery*. Anesthesiology 2011; 114(1): *25-33*.
2) Shiga T, Wajima Z, Inoue T, Sakamoto A: *Predicting difficult intubation in apparently normal patients: a meta-analysis of bedside screening test performance*. Anesthesiology 2005; 103: *429-37*.
3) American Society of Anesthesiologists Task Force on Management of the Difficult Airway: *Practice guidelines for management of the difficult airway: An updated report by the American Society of Anesthesiologists Task Force on Management of the Difficult Airway.* Anesthesiology 2003; 98: 1269-77.
4) Peterson GN, Domino KB, Caplan RA, Posner KL, Lee LA, Cheney FW: *Management of the difficult airway: a closed claims analysis*. Anesthesiology 2005; 103: *33-9*.
5) Asai, T: V*ideolaryngoscopes: do they truly have roles in difficult airways?* Anesthesiology 2012 Mar; 116(3): 515-7.
6) Author/s: *Recommendations for airway control and difficult airway management*. Minerva Anestesiologica 2005; 71: *617*.
7) Maybauer MO, Maier S, Thierbach AR: *An unexpected difficult intubation: Bonfils rigid fiberscope*. Anaesthesist 2005; 54(1): *3540*.
8) Schmidt U, Eikermann, M: *Organizational aspects of difficult airway management: think globally, act locally*. Anesthesiology 2011; 114 (1): *3-6*.
9) May H, Brady SM, Guohua L: *The epidemiology of upper airway injury in patients undergoing major surgical procedures*. A & A 2012; 114 (1): 148.
10) Aziz MF, Healy D, Kheterpal S, Fu RF, Dillman D, Brambrink AM: *Routine clinical practice effectiveness of the Glidescope in difficult airway management: an analysis of 2,004 Glidescope intubations, complications, and failures from two institutions*. Anesthesiology 2011; 114(1): *34-41*.
11) Koh LK, Kong CE, Ip-Yam PC: *The modified Cormack-Lehane score for the grading of direct laryngoscopy: evaluation in the Asian population*. Anaesth Intensive Care 2002; 30(1): *48-51*.
12) Sharma D, Kim LJ, Ghodke B: *Successful airway management with combined use of Glidescope videolaryngoscope and fiberoptic bronchoscope in a patient with Cowden syndrome*. Anesthesiology 2010 Jul; 113(1): 253-5.
13) Kawamoto E, Wakamatsu M, Fujikake K, Machino A, Kaida T, Nagasaka Y: *A case-control study of airway management for 68 patients with cervical spine injury: comparison of the direct laryngoscope with a Macintosh blade and the fiberoptic bronchoscope*. Masui 2010 Aug; 59(8): 976-80 (In Japanese).
14) Xue FS, Liu JH, Yuan YJ, Liao X: *Comments on comparison of the combined Airtraq® laryngoscope and a fiberoptic bronchoscope with the Airtraq® alone for tracheal intubation*. J Anesth 2011 Jun; 25(3): *465-6*.
15) Abdelmalak BB, Bernstein E, Egan C, Abdallah R, You J, Sessler DI, Doyle DJ: GlideScope® vs flexible fibreoptic scope for elective intubation in obese patients. Anaesthesia 2011 Jul; 66(7): 550–5
16) Weissbrod PA, Merati AL: *Reducing injury during video-assisted endotracheal intubation: the "smart stylet" concept*. Laryngoscope 2011 Nov; 121(11): *2391-3*.

Request reprints from:
Prof. CALOGERO GRILLO
Via delle Rose
95030 S. A. Li Battiati (CT)
(Italy)