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

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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. SaO2 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.

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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.

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 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. 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).

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).

![Algorithm for easy intubation](image)

**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 endpoint 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).

<table>
<thead>
<tr>
<th>Difficulty Score (Procedure Time)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (within 1 min.)</td>
</tr>
<tr>
<td>2 (within 3 min.)</td>
</tr>
<tr>
<td>3 (up 3 min.)</td>
</tr>
</tbody>
</table>

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% O₂ 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).

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, SaO₂, 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 SaO₂ 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,
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).

### Table 3: Result Combined Technique - Total Cases.

<table>
<thead>
<tr>
<th>Cases</th>
<th>Success</th>
<th>Failure</th>
<th>Traumatic Injuries</th>
<th>Percentage Success</th>
<th>Percentage Failures</th>
<th>SaO₂ 95-100%</th>
<th>Percentage SaO₂ 95–100%</th>
</tr>
</thead>
<tbody>
<tr>
<td>314</td>
<td>314</td>
<td>0</td>
<td>0</td>
<td>100</td>
<td>0</td>
<td>314</td>
<td>0</td>
</tr>
</tbody>
</table>

### Table 4: Result Algorithm Group.

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Percentage</th>
<th>Percentage valid</th>
<th>Percentage cumulative</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>180</td>
<td>57,3</td>
<td>57,3</td>
</tr>
<tr>
<td>2</td>
<td>83</td>
<td>26,4</td>
<td>83,8</td>
</tr>
<tr>
<td>3</td>
<td>42</td>
<td>13,4</td>
<td>97,1</td>
</tr>
<tr>
<td>4</td>
<td>9</td>
<td>2,9</td>
<td>100,0</td>
</tr>
<tr>
<td>total</td>
<td>314</td>
<td>100,0</td>
<td>100,0</td>
</tr>
</tbody>
</table>

### Table 5: Cormak Lehane Index (ICL).

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Percentage</th>
<th>Percentage valid</th>
<th>Percentage cumulative</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>253</td>
<td>80,6</td>
<td>80,6</td>
</tr>
<tr>
<td>2</td>
<td>53</td>
<td>16,9</td>
<td>97,5</td>
</tr>
<tr>
<td>3</td>
<td>8</td>
<td>2,5</td>
<td>100,0</td>
</tr>
<tr>
<td>total</td>
<td>314</td>
<td>100,0</td>
<td>100,0</td>
</tr>
</tbody>
</table>

### 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(19). 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 com-
bined 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 bronchoscopy.

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


