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Original Contribution

Optimal external laryngeal manipulation: modified bimanual laryngoscopy

Jinyoung Hwang MD[a], Sanghyon Park MD[b], Jin Huh MD[a], Jinhee Kim MD[b], Kyuseok Kim MD[c], Ahyoung Oh MD[b], Sunghee Han MD[b,*]

[a]*Department of Anesthesiology and Pain Medicine, Boramae Municipal Hospital 156-707, Republic of Korea*
[b]*Department of Anesthesiology and Pain Medicine, Seoul National University College of Medicine, Seoul National University Bundang Hospital 463-707, Republic of Korea*
[c]*Department of Emergency Medicine, Seoul National University College of Medicine, Seoul National University Bundang Hospital 463-707, Republic of Korea*

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Abstract

Objectives: External laryngeal manipulation (ELM) is commonly used to facilitate laryngeal view during direct laryngoscopy. We evaluated the effectiveness of the newly modified bimanual laryngoscopy, which involves a direct guidance of an assistant's hand by a laryngoscopist, to optimize laryngeal exposure during direct laryngoscopy compared with conventional bimanual laryngoscopy.

Methods: A total of 78 adult patients were included. Patients were randomly allocated to 1 of 2 groups: group C (ELM using conventional bimanual laryngoscopy) or group M (ELM using the modified bimanual laryngoscopy). The difference in percentage of glottic opening scores after the application of ELM, the number of ELM attempts, and the time taken to obtain the best laryngeal view during ELM were recorded.

Results: The differences in the percentage of glottic opening score before and after the initial attempt of ELM significantly improved in group M compared with group C (40% [30%-50%] vs 30% [15%-35%], median [interquartile range], respectively; $P < .001$). The success rate of achieving the best laryngeal view on the first attempt was higher in group M than in group C (87% vs 36%, respectively; $P < .001$). The time taken for obtaining the best laryngeal view after the first ELM attempt was significantly shorter in group M than in group C (3 [3-4] vs 7 [4-8] seconds, median [interquartile range], respectively; $P < .001$).

Conclusion: The modified bimanual laryngoscopy is more effective for obtaining the optimal laryngeal view on the first attempt compared with the conventional bimanual laryngoscopy.

1. Introduction

Tracheal intubation by direct laryngoscopy is the mainstay of airway management in clinical settings, and the degree of laryngeal exposure is the main determinant of successful tracheal intubation during direct laryngoscopy. Cricoid pressure and backward-upward-rightward pressure

* Corresponding author. Department of Anesthesiology and Pain Medicine, Seoul National University Bundang Hospital, 166 Gumi-ro, Bundang-gu, Seongnam-si, Gyeonggi-do, 463–707, Republic of Korea. Tel.: +82 31 787 7498; fax: +82 31 787 4063.

E-mail addresses: anesthesiology@snubh.org, noninvasive@hanmail.net (S. Han).

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(BURP) have been commonly used for improving laryngeal exposure [1,2]. However, some studies have demonstrated that cricoid pressure and BURP frequently worsen laryngeal view [3-5].

Bimanual laryngoscopy that involves operator-directed manipulation of the thyroid cartilage has been introduced [6] and has been suggested to be more effective than cricoid pressure and BURP for improving laryngeal exposure [7]. During conventional bimanual laryngoscopy, a laryngoscopist applies thyroid cartilage pressure using his/her right hand to obtain the best laryngeal view; and then an assistant takes over the laryngoscopist's external laryngeal manipulation (ELM). However, it would be difficult to simulate the same position, direction, or force as those of the laryngoscopist's manipulation. Therefore, the optimal laryngeal view guided by the laryngoscopist can be changed while it is taken over by the assistant, which might worsen the optimal laryngeal view.

Particularly in emergency airway management, it is crucial to achieve the best laryngeal view promptly for rapid and successful tracheal intubation. Thus, the authors developed a newly modified bimanual laryngoscopy. During the modified bimanual laryngoscopy, instead of taking over the laryngoscopist's ELM, an assistant lays a hand on the patient's thyroid cartilage; and then a laryngoscopist directly guides the assistant's hand to achieve the best laryngeal view. The aim of this study is to determine the effectiveness of the modified bimanual laryngoscopy to optimize laryngeal exposure during direct laryngoscopy. We compared the difference in percentage of glottic opening (POGO) scores after the application of ELM, the number of ELM attempts, and the time taken to obtain the best laryngeal view during the conventional bimanual laryngoscopy or the modified bimanual laryngoscopy.

2. Methods

This study was approved by the Institutional Review Board of our university hospital, and written informed consent was obtained. A total of 130 adult patients scheduled for elective surgery requiring direct laryngoscopic intubation were screened for enrollment. Five experienced laryngoscopists performed all laryngoscopies with a curved blade (in men, a Macintosh blade #4; in women, a Macintosh blade #3). They graded each laryngoscopy using the validated POGO score form 0% to 100%. A POGO score of 100% corresponds to full visualization of the larynx from the interarytenoid notch to the anterior commissure of the vocal cords, and a POGO score of 0% means no visualization of the glottic opening [8]. Laryngoscopists were reminded of the POGO scoring system before starting the study, and poster-size illustrations were used to aid classification. After confirming the laryngeal view with the standard technique, patients whose initial POGO score exceeded 50% and for whom ELM was usually not required were excluded. An investigator with no clinical involvement in our study allocated the patients randomly to 1 of 2 groups using block randomization (block size 6). A second investigator, also with no clinical involvement in the present study, assigned the groups—group C (ELM using conventional bimanual laryngoscopy) or group M (ELM using modified bimanual laryngoscopy)—by opening an opaque sealed envelope.

For conventional bimanual laryngoscopy, the laryngoscopist applied thyroid cartilage pressure using his/her right hand to obtain the best laryngeal view and instructed an assistant to "press in this way." The assistant followed the instructions until the laryngoscopist could achieve the same laryngeal view as he/she manipulated. The modified bimanual laryngoscopy involves the following steps. An assistant laid his/her hand on the patient's thyroid cartilage, and then the laryngoscopist guided the assistant's hand with his/her right hand to achieve the best laryngeal view and said "keep the pressure and direction." The assistant maintained the pressure on the thyroid cartilage in the same direction and with same force as guided by the laryngoscopist during the tracheal intubation. The ELM was performed by nurses, surgeons, or participating residents with no clinical involvement in our study.

The primary outcome was the degree of improvement of POGO score at the first ELM attempt, which was assessed by the absolute value differences of POGO score. The secondary outcomes included the number of ELM attempts and the time for obtaining the best laryngeal view. The *time for obtaining the best laryngeal view* was defined as the time between confirming the initial laryngeal view and obtaining the best laryngeal view after the application of ELM. If the laryngoscopists did not obtain the best view after 3 ELM attempts, the ELM was recorded as a failure; and the next step in airway management proceeded at the laryngoscopist's discretion. Time data for obtaining the best laryngeal view in patients with a failed ELM after 3 attempts were excluded from the data calculation.

The sample size calculation was performed using Power Analysis and Sample Size software (2005; NCSS, Kaysville, UT). Accepting a detectable POGO score difference of 20 after the first attempt of ELM between the 2 groups, 39 patients were required for each group at a significance level of 95% with a power of 90%. Therefore, patients were enrolled until 39 patients per group were assigned after excluding cases in which the initial POGO score exceeded 50%. Data were presented as numbers, percentages, means (SD), or median (interquartile range [IQR]). The SPSS software (version 12.0; SPSS Inc, Chicago, IL) was used for statistical analysis. The normality of the data was tested using the Lilliefors test. Student t test was used to analyze the demographic data, and Mann-Whitney U test was used to analyze the POGO scores and the time for obtaining the best laryngeal view with each method. The number of ELM attempts was

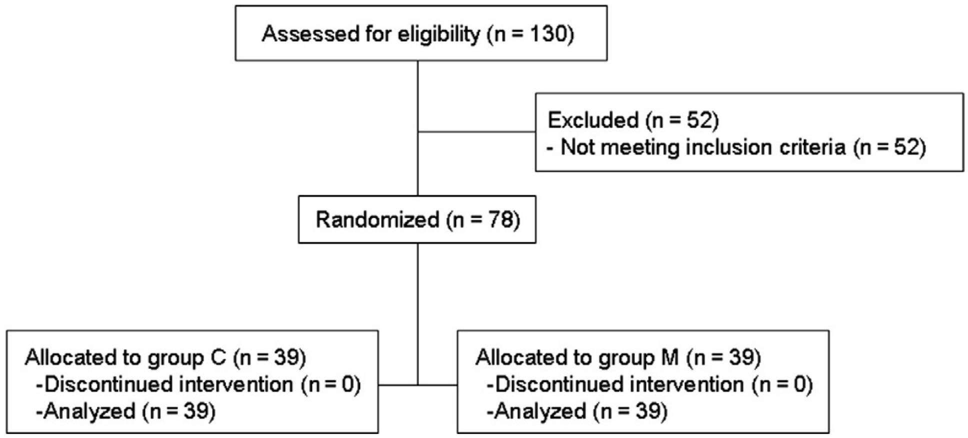

Fig. 1 Flow diagram.

compared using Fisher exact test. Statistical significance was accepted for a P value < .05.

3. Results

A total of 130 patients were assessed for eligibility from December 2010 to February 2011. Fifty-two patients were excluded because the initial POGO score exceeded 50%, and 78 patients completed the study (Fig. 1).

Demographic data are summarized in Table 1. No significant differences were found between the 2 groups in terms of age, weight, height, sex, or initial Mallampati score.

The POGO score after the initial ELM attempt significantly increased with the modified bimanual laryngoscopy compared with the conventional bimanual laryngoscopy (Fig. 2). In group M, the first ELM attempt improved the POGO score in all patients. However, in group C, the first ELM attempt improved POGO score only in 87.2% of patients; and furthermore, the POGO score was not changed in 7.7% of patients and decreased in 5.1% of patients. The number of ELM attempts is presented in Table 2. The success rate of achieving the best laryngeal view on the first attempt was higher in group M than in group C (87% vs 36%, respectively; $P < .001$). The time taken for obtaining the best laryngeal view was significantly shorter in group M compared with group C (3 [3-4] vs 7 [4-8] seconds, respectively; $P < .001$).

Table 1 Patient characteristics

	Group C (n = 39)	Group M (n = 39)
Age (y)	53 (13)	54 (12)
Sex (M/F)	15/24	16/23
Weight (kg)	61 (12)	61 (9)
Height (cm)	161 (9)	161 (8)
ASA class I/II	20/19	23/16

Values shown are the means (SD) or patient numbers. ASA indicates American Society of Anesthesiologists.

4. Discussion

The present study shows that the modified bimanual laryngoscopy is significantly more prompt and effective for obtaining the best laryngeal view on the first attempt compared with the conventional bimanual laryngoscopy.

Direct laryngoscopy has been a standard technique for tracheal intubation, and the ELM has been an important method for improving laryngeal visualization during direct laryngoscopy [9,10]. The use of ELM facilitates the laryngeal exposure by improving the alignment of the larynx with the line of vision, effectively elevating the epiglottis and

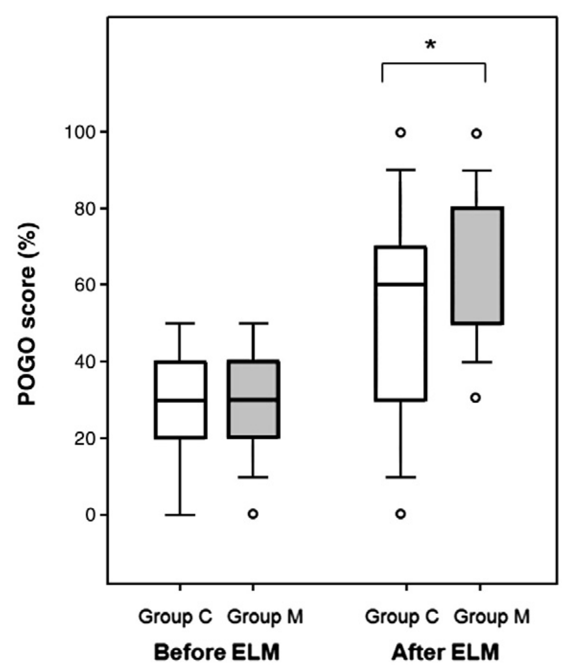

Fig. 2 The improvement of POGO score after the first ELM attempt. Data are presented as box plots. The horizontal box line represents the 75th, 50th, and 25th percentiles. The stems represent the 90th and 10th percentiles. The circles indicate points beyond the 10th and 90th percentiles. *$P < .05$ between group C and group M.

Table 2 The number of ELM attempts

	Group C (n = 39)	Group M (n = 39)
1	14 (36%)	34 (87%) *
2	10 (26%)	5 (13%) *
3	6 (15%)	0 (0%) *
Fail	9 (23%)	0 (0%) *

Values shown are the patient numbers (percentages).
* $P < .05$

reducing the anterior tilt of the larynx [11,12]. Several techniques including cricoid pressure, BURP, and bimanual laryngoscopy have been suggested for ELM during direct laryngoscopy. Since it was first described in 1961, cricoid pressure, a technique to reduce the risk of the aspiration of stomach contents during the induction of general anesthesia, has been used to move the larynx posteriorly to facilitate visualization during laryngoscopy [1]. The “BURP” maneuver entails the displacement of the larynx with backward, upward, and rightward pressure on the thyroid cartilage during direct laryngoscopy, which was suggested to improve the glottic view during direct laryngoscopy in 1993 [2]. These 2 maneuvers, both performed by an assistant, have been a common practice for airway management for several decades; but numerous studies have questioned their effectiveness in laryngeal visualization and showed that cricoid pressure or BURP might worsen laryngoscopic view [3-5,7,13,14].

It has been suggested that the best way for optimal ELM is for the laryngoscopist to determine the exact area on the neck and the amount of pressure with his own free right hand [15]. Unlike cricoid pressure or BURP, bimanual laryngoscopy is designed to improve laryngeal view with the cooperation between the laryngoscopist and an assistant during direct laryngoscopy [6]. The laryngoscopist manipulates the larynx under direct vision, and an assistant holds the best position until the tracheal tube is passed. Levitan et al [7] showed that bimanual laryngoscopy improves laryngeal view compared with cricoid pressure or BURP. However, during bimanual laryngoscopy, the laryngeal view guided by a laryngoscopist can be changed while it is taken over by an assistant, which might worsen the optimal laryngeal view because it would be difficult to achieve the same position, direction, or force as those of the laryngoscopist’s manipulation. Our study also showed that the POGO score with conventional bimanual laryngoscopy worsened in some cases.

For the modified bimanual laryngoscopy, an assistant lays a hand on the patient’s thyroid cartilage; and then a laryngoscopist manipulates the assistant’s hand to achieve the best laryngeal view. The assistant presses the thyroid cartilage with the same direction and force based on the laryngoscopist’s guidance and maintains the pressure while tracheal intubation is performed. Thus, the optimal laryngeal view for the laryngoscopist is maintained during direct laryngoscopy.

In the present study, the cases involving the failure to obtain the best laryngeal view in conventional bimanual laryngoscopy were excluded from the data (time) analysis. Therefore, with the use of conventional bimanual laryngoscopy, the actual time taken for the best laryngeal view would be much longer. Taking a few seconds more for obtaining the best laryngeal view on the first ELM attempt might be considered clinically insignificant. However, it could not be ignored because airway management in prehospital settings would be more challenging compared with the controlled environment and effective ELM could be more important for successful tracheal intubation. Furthermore, repeated laryngoscopic attempts are associated with increased patient morbidity [16]. Accordingly, we suggest that the modified bimanual laryngoscopy might be helpful for effective airway management.

Besides, it is well known that the application of cricoid pressure requires training because the misapplication of cricoid pressure can be harmful and worsen the laryngeal view [13,17]. It is likely that an assistant who performs ELM entirely needs training. On the other hand, the modified bimanual laryngoscopy is performed under the laryngoscopist’s direct guidance. Therefore, effective and accurate ELM for optimal laryngeal view could be possible without a specific training, which is helpful particularly in prehospital settings.

This study has several limitations. First, this study was conducted at a single center; and the results may not be generalized to other institution. Second, both the laryngoscopists and the observers who collected the data were unblinded. This is a possible factor of bias. However, this study was performed following a detailed protocol; and observers’ biases should have little effect on the results of the study.

In conclusion, the modified bimanual laryngoscopy is more effective for obtaining the optimal laryngeal view on the first attempt compared with the conventional bimanual laryngoscopy.

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