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The BURP Maneuver Assists Inexperienced Health Care Professionals to Visualize Patient's Glottis and Increase the Success Rate in Performing Endotracheal Intubation

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Abstract

Objective: Comparing the effectiveness of the BURP (backward, upward, rightward pressure) maneuver versus conventional external laryngeal manipulation (ELM) in improving glottic visualization and intubation success rates among inexperienced healthcare professionals.

Methods: This randomized, double-blind, crossover study was conducted at Siriraj Hospital among 56 patients (ASA I-II) undergoing general anesthesia. Participants were randomized to receive the BURP maneuver followed by the conventional ELM technique or vice versa. Laryngoscopies and intubations were performed by inexperienced healthcare professionals who were blinded to the external manipulation technique. The BURP maneuver was applied by a single trained anesthesiologist, and the conventional ELM technique by nurse anesthetists who had not been trained in the BURP method. The primary outcome was laryngeal view (LV) grade change; the secondary outcome was intubation success. Patients with a grade 1 LV were excluded from paired analysis. Data were analyzed using paired t-tests and Wilcoxon signed-rank tests.

Results: The BURP maneuver significantly improved glottic visualization compared to the conventional technique ($p < 0.001$). No grade 3 or 4 LV was observed in the BURP group, while 6 cases were in the conventional group. Four patients who could not be intubated with the conventional technique were successfully intubated after applying BURP while all BURP patients were successfully intubated.

Conclusion: BURP improves glottic visualization and increase the first-pass intubation success rate in novice intubators. Incorporating BURP into airway management training may improve safety and outcomes.

Keywords: airway management training, BURP maneuver, external laryngeal manipulation, glottic visualization, intubation success

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Introduction

Tracheal intubation is a critical, high-risk but important procedure for health care professionals to save life in many situations. Endotracheal intubation by laryngoscopy remains the primary means of airway management while successful intubation relies on optimal laryngeal exposure as first described by Cormack and Lehane since 1984.[1] Factors influencing successful intubation include patient-related anatomy and operator skill.[2] Techniques such as proper head and neck positioning[3], appropriate blade selection, and external laryngeal manipulation are commonly recommended to improve visualization during laryngoscopy.[4]

External laryngeal manipulation (ELM) was the common and simple intervention to displace the vocal cords and help glottic exposure. In the conventional manipulation technique, an assistant applied external pressure with variable force and direction, adjusting it dynamically based on their own skill and the laryngoscopist's real-time visual feedback, until the optimal view of the vocal cords was achieved.[5] The technique called bimanual laryngoscopy showed the good outcome for improving the exposure.[6-8] In this technique the laryngoscopist applied thyroid cartilage with pressure directed posteriorly and cephalad until optimal visualization occurred and then an assistant took responsibility for maintaining laryngeal pressure .The laryngoscopist passes the endotracheal tube into the trachea. Nevertheless, both techniques might be more difficult for inexperienced healthcare professionals to guide the direction of pressure by themselves.

Knill introduced the BURP (backward, upward, rightward pressure) maneuver as a structured method to standardize external laryngeal manipulation by an assistant, demonstrating its potential to improve glottic view.[9] The pressure was applied to the thyroid cartilage by an assistant. Prescribed movements were backward (posterior) pressure: pushing the thyroid cartilage posteriorly towards the cervical vertebrae. This helped to align the laryngeal axis with the line of vision. Upward (cephalad) pressure directed the larynx superiorly towards the patient's head. This could elevate the epiglottis and brought the vocal cords into view. Rightward (to the patient's right) pressure shifted the larynx laterally towards the patient's right. This helped to bring the glottic opening into the center of the visual field.

Despite the widespread recognition and utility of the BURP maneuver in optimizing glottic visualization during direct laryngoscopy, its application is not well known at our institution. Furthermore, there is limited evidence concerning its use by inexperienced healthcare professionals.[10] Therefore, this study seeks to evaluate the impact of standardized BURP application on glottic visualization and increase the first-pass intubation success rate in performing endotracheal intubation among novice intubators compared to conventional laryngeal manipulation techniques which commonly used at our institute. This study aimed to compare the effectiveness of the BURP maneuver versus conventional external

laryngeal manipulation in improving glottic visualization (laryngeal view, LV) and first-pass intubation success rate by inexperienced healthcare professionals.

Material and methods

A randomized, double-blind, crossover study was conducted at Siriraj Hospital between February and October 2018. Ethical approval was obtained from the Siriraj Institutional Review Board (COA no. 255/2560 (EC3)). Patients aged over 18 years, classified as ASA physical status I-II, and scheduled for general anesthesia with endotracheal intubation were eligible for inclusion. Exclusion criteria included obvious head or neck malformations, anticipated difficult intubation (assessed by an anesthesiologist), risk of aspiration, history of anesthesia-related allergies, or a history of difficult intubation. An informed consent was obtained from all participants prior to surgery. Patients were withdrawn from the study if they declined to participate.

Baseline demographic data, including mouth opening, thyromental distance, neck circumference, and Mallampati score, were recorded. All patients were placed in the supine position with standard monitoring and preoxygenation. General anesthesia was administered using a standardized technique, including premedication, induction agents, and neuromuscular blockade. After induction, patients were positioned in the sniffing position. Ventilation was done until full neuromuscular relaxation was achieved. Direct laryngoscopy was performed by inexperienced healthcare providers (medical students, nurse anesthetist students, and anesthesia residents in their first three months of training) using a curved laryngoscope blade.

By cross over design patients were randomized using a computer-generated sequence into two groups: BURP maneuver followed by the conventional technique (BURP-to-conventional group) and conventional technique followed by BURP (conventional-to-BURP group). The LV was assessed and graded according to the Cormack-Lehane classification system (grades 1-4) as the baseline measurement. Patients with grade 1 LV were excluded as external laryngeal manipulation was not indicated. The BURP maneuver was performed by a single anesthesiologist trained in the technique, while the conventional technique was performed by nurse anesthetists who had not been trained in the BURP. Both procedures were conducted behind a screen to ensure that the laryngoscopist remained blinded to the sequence.

After each external laryngeal manipulation, the LV grade was recorded. To account for the variability within a grade 2 LV[11,12] to capture subtle shifts in visualization, changes were quantified by adding or subtracting 0.5 from the grade 2 LV score based on improvement or worsening compared to the preceding attempt. A 1.5 score denoted a view better than grade 2 but not quite grade 1, while a 2.5 score indicated a view worse than grade 2 but not yet grade 3. The refined scoring scale (1, 1.5, 2, 2.5, 3, 4) provided a more precise measure of the immediate effect of interventions on glottic exposure. Following the second

maneuver and LV assessment, an endotracheal intubation was performed, and the success was confirmed by end-tidal carbon dioxide monitoring. If intubation was unsuccessful due to a poor LV, the preceding external laryngeal manipulation technique was repeated, and the outcome (success or failure) was recorded. If the laryngoscopist was unable to intubate the patient after two attempts, an experienced anesthesiologist performed the intubation to ensure patient safety. (Figure 1)

The sample size calculation was based on an α of 0.05, a power of 80%, and an anticipated discordance rate of 0.35. This discordance rate was derived from a combination of preliminary data, literature review, and clinical assumptions, incorporating an estimated 5% baseline discordance-reflecting natural variability in glottic view grading-and an anticipated 30% improvement in laryngoscopic view grade with the BURP technique. The expected improving laryngoscopic view grade for the conventional technique (P_1) was 0.65, while the expected improving laryngoscopic view grade for the BURP technique (P_2) was 0.90. Based on these assumptions, the required sample size for patients with a LV grade >1 was calculated to be 38. After accounting for an estimated 30% exclusion rate due to patients presenting with a grade 1 LV, the final target sample size was set at 56 patients.

Given the crossover design of the study, each patient was scheduled to undergo both the BURP and conventional techniques in a

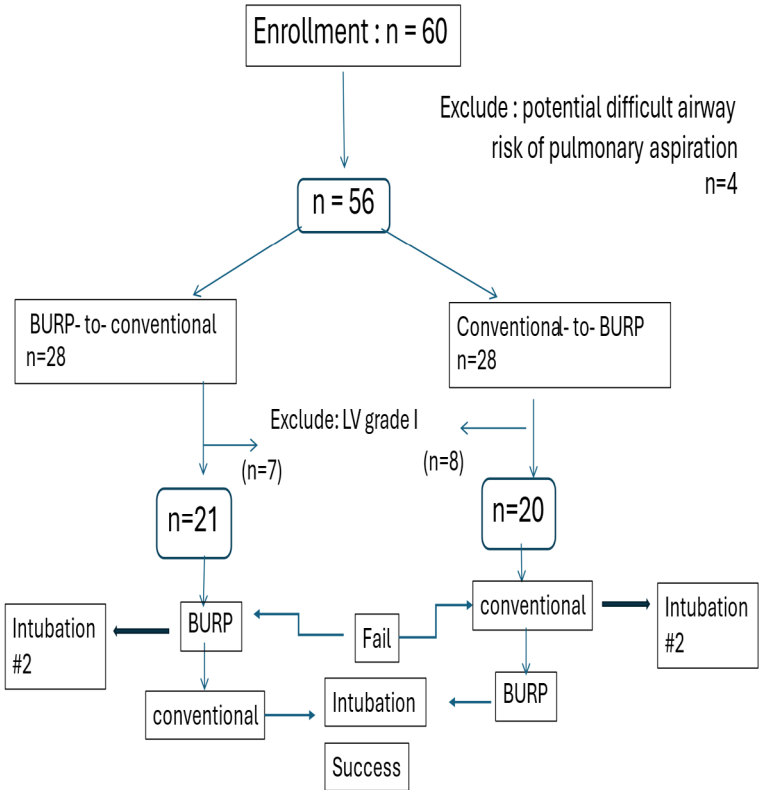


Figure 1 Study flow diagram

randomized sequence, with outcomes compared using paired analysis. Each patient served as their own control to minimize inter-patient variability and enhance the precision of the findings. Statistical analyses were performed using paired t-tests and Wilcoxon signed-rank tests as appropriate, with a significance level set at $P < 0.05$. All analyses were conducted using SPSS version 21.0 (Chicago, IL, USA).

Results

After obtaining informed consent from 60 eligible patients, a final assessment for potential difficult airway and risk of pulmonary aspiration was performed by the attending anesthesiologist on the day of the procedure. Four patients were excluded based on this assessment, resulting in 56 patients who were enrolled and randomized into the study. (Figure 1) The LV was assessed and graded at baseline. Fifteen patients (7 in BURP-to-conventional group and 8 in conventional-to-BURP group) were initially found to have an LV grade 1 and were subsequently excluded from the study. Consequently, a total of 41 patients were included in the final analysis. There were no statistically significant differences in demographics and airway assessment variables between the two groups. (Table 1)

Our results, presented in a cross-tabulation (Table 2), specifically illustrate the paired comparison of LV grades. In this table, rows represent the LV grade achieved with the

Table 1 Demographic data

	BURP-to-conventional (n=21)	Conventional-to -BURP (n=20)	*P*-value
Age (yr), mean±SD	55.4±14.9	56.0±13.4	0.893
Female: Male, n	15:6	15:5	>0.999
ASA class, n I II III	 7 9 5	 4 13 3	0.364
Mouth opening (cm), mean±SD	5.1±0.8	5.1±0.9	0.821
Thyromental (cm), mean±SD	6.9±1.2	6.9±1.1	0.977
Neck circumference (cm), mean±SD	32.9±3.8	34.7±6.0	0.273
Mallampati grading, n 1 2 3	 3 13 5	 3 12 5	0.992

Table 2 Within-patient comparison of laryngeal view grades

	BURP LV gr1	BURP LV gr 1.5	BURP LV gr 2		*P*-value
Conventional LV gr 1	6	5	-	11 (26.8)	
Conventional LV gr 1.5	11	-	1	12 (29.3)	
Conventional LV gr 2	6	2	1	9 (22.0)	
Conventional LV gr 2.5	-	-	3	3 (7.3)	
Conventional LV gr 3	4	-	1	5 (12.2)	
Conventional LV gr 4	1	-	-	1 (2.4)	
Total (%)	28 (68.3)	7(17.1)	6 (14.6)	41 (100.0)	<0.001*

Values represent the number of patients assigned to each laryngeal view (LV) grade. Statistical analysis was performed using the Wilcoxon signed-rank test.

conventional ELM technique, while columns represent the LV grade with the BURP technique for the same patient. This allows for a clear visualization of how the LV grade changed for each individual, enabling us to categorize patients as 'improved,' 'no change,' or 'worsened' when using BURP compared to the conventional approach. This analysis revealed that relative to the conventional technique the BURP maneuver resulted in an improved LV grade in 28 patients (68.3%), no change in 7 patients (17.1%), and worsened the view in 6 patients (14.6%). Due to the paired nature of our comparison (i.e., each patient served as their own control), these findings inversely confirm that the conventional technique resulted in a superior view compared to BURP in 6 patients, an identical view in 7 patients, and an inferior view compared to BURP in 28 patients. Wilcoxon signed-rank test confirmed a significant improvement in LV grade with the BURP technique ($P < 0.001$). This was further evidenced by more patients achieving favorable views (grade 1 and 2) with BURP, and notably, no grade 3 or 4 views were observed with BURP, compared to 6 patients who presented with such views under the conventional method. These findings reinforce the BURP maneuver's advantage in improving laryngeal visualization.

The distribution of change in LV grade from baseline measurement is illustrated in Figure 2. The distribution pattern demonstrates that the majority of patients with BURP technique experienced a one-grade improvement (-1) of glottic visualization compared to baseline. In contrast, the conventional technique exhibited a broader spread of changes, with fewer patients achieving a one-grade improvement, and one patient showing a worsening of 2.5 LV grades. The BURP technique demonstrated a significantly greater improvement in LV grade from the baseline measurement compared to the conventional technique ($P < 0.001$). Ultimately, all patients underwent successful intubation. In four cases where intubation failed with the conventional

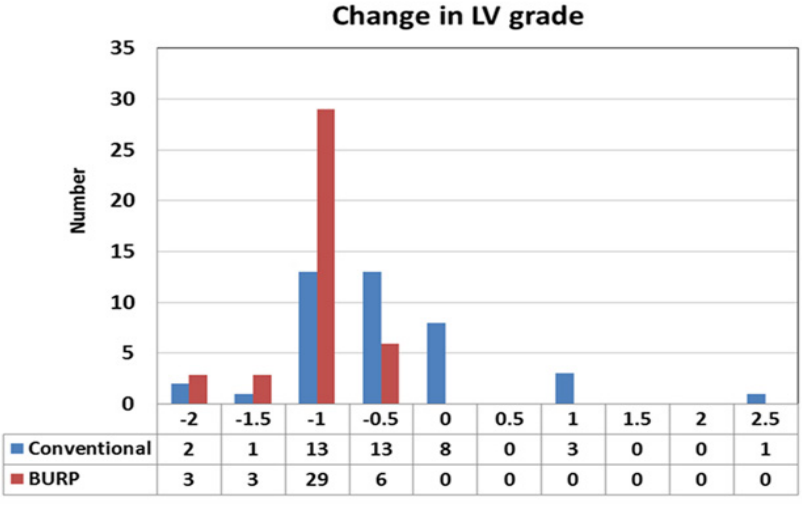


Figure 2 Change in LV grade from baseline Negative values indicate an improvement in LV grade.

technique, the success was achieved following the application of the BURP maneuver. Of note, all patients intubated using the BURP technique were successfully intubated.

Discussion

This randomized, double-blind, crossover study demonstrated that the BURP maneuver significantly improves glottic visualization compared to conventional external laryngeal manipulation. The crossover design is a major strength, as it allowed each patient to serve as their own control, thereby minimizing inter-patient variability. Additionally, the BURP technique was consistently applied by a single, trained anesthesiologist, ensuring standardized execution across all cases. In contrast, the conventional ELM group showed considerable variability in technique. Although none of the nurse anesthetists assisting in this group had formal BURP training, two experienced practitioners (> 15 yr of clinical practice) were observed applying pressure patterns resembling BURP. The remaining eight assistants predominantly used only backward pressure. This inconsistency highlights the non-standardized nature of conventional ELM in real-world practice, particularly in teaching hospitals where assistants often have varying levels of training and experience. While such variability could potentially introduce bias, the consistent superiority of the BURP technique across this range of operator performance reinforces its reliability and generalizability.

Considering the expected variations within Cormack-Lehane (CL) grade 2, previous studies have proposed subclassifying it into 2a and 2b.[11,12] In our study, we adopted a numerical modification by assigning intermediate values (e.g., 1.5 or 2.5) to reflect subtle improvements or deteriorations in glottic view relative to the baseline. This modified scoring system (1, 1.5, 2, 2.5, 3, 4) offered a detailed and quick assessment of the immediate effects of each technique. Our findings align with

existing literature supporting the utility of the BURP maneuver. Knill's original description[9] and Takahata and coworkers[5] demonstrated that BURP enhances laryngeal exposure during direct laryngoscopy, particularly in challenging airways. Kaur and colleagues similarly reported favorable outcomes in patients with thyroid pathology.[13] Conversely, the other reports observed mixed results, particularly when BURP was combined with cricoid pressure or tested in cadaver models emphasis that proper technique and clinical context are essential for efficacy.[14,15]

A recent study has compared BURP with other adjuncts like jaw thrust, showing that BURP provides superior laryngoscopic grading, particularly among novice practitioners.[16] Alternative methods such as bimanual laryngoscopy where the intubator first optimizes the view and an assistant maintains the pressure have gained interest. While supported by Levitan and coworkers[15] and resources like LITFL[17], bimanual techniques require higher operator skill and are less feasible for early learners, making BURP a more accessible option in training environments. While the BURP maneuver is generally safe and effective, certain precautions should be considered. Incorrect application or excessive pressure may distort the airway anatomy, obscure the glottic view, or hinder intubation particularly in patients with restricted neck mobility or airway anomalies. BURP must also be distinguished from cricoid pressure[14], which has a different purpose and anatomical target. Training should emphasize proper technique and indications to avoid misuse, especially in emergent or complex airway scenarios.

Although the primary outcome of this study was glottic visualization, we also evaluated intubation success as a secondary outcome. All patients were successfully intubated, including four who initially failed intubation with the conventional technique but were subsequently intubated after the application of BURP. This suggests that BURP not only improves visualization but also enhances the likelihood of successful intubation, particularly in challenging or borderline cases. This is of particular relevance in teaching environments where novice practitioners perform intubation under supervision. As video laryngoscopy becomes more widely utilized, the efficacy of adjunctive maneuvers, including BURP, requires more robust testing for their application in various difficult airway contexts.[18,19] Innovative approaches, including predictive modeling using machine learning may help tailor airway strategies in the future.[20] Although our study did not incorporate such tools, the concept of individualized airway management is an exciting direction for further research.

This study has several limitations that warrant consideration. First, as a single-center study conducted at a specific teaching hospital, the generalizability of our findings to other institutions or diverse patient populations may be limited. Second, a crucial aspect is that our study exclusively utilized direct laryngoscopy for intubation, despite the contemporary prevalence of video laryngoscopy in airway management. While our results demonstrate the efficacy of the BURP maneuver in improving laryngeal visualization during direct laryngoscopy, these findings may not be directly transferable

to video laryngoscopy without further investigation. Future research is needed to validate BURP's utility in the video laryngoscopic context. Third, our exclusion of patients with anticipated difficult airways restricts the direct applicability of our findings to routine intubations, rather than to the most challenging airway scenarios. Finally, while employing a single, trained anesthesiologist for the BURP maneuver ensured high standardization and internal validity, it inherently limits the generalizability of BURP's effectiveness when performed by assistants with less specialized training or varying levels of experience. This highlights a potential area for future research exploring BURP's effectiveness across a broader range of assistant experience levels and investigating optimal strategies for teaching and integrating the BURP maneuver into standardized airway management curricula. Such studies could explore various teaching modalities and evaluate the learning curve associated with acquiring proficiency in BURP applications among different healthcare professional groups.

Conclusion

The BURP maneuver significantly enhances glottic visualization and increases the success rate of endotracheal intubation among inexperienced healthcare professionals in patients with laryngeal view grades greater than 1. Unlike nonspecific ELM manipulation, BURP consistently improved or maintained the glottic view without deterioration. Given its simplicity, cost-free nature, and clinical effectiveness, integrating BURP training into early airway management curricula for both intubators and assistants may strengthen procedural skills, build confidence among novice practitioners, and improve overall patient safety.

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