Submitted: 05 December, 2023 Accepted: 12 March, 2024 Online Published: 31 May, 2024 DOI:10.22514/sv.2024.065

Open Access
Signa Vitae

ORIGINAL RESEARCH

Comparison of lightwand intubation technique in neck-immobilized patients with face-to-face and conventional approaches

Kyeong-Hyeon Min[1], Hyungseok Seo[1,*]

[1]Department of Anesthesiology and Pain Medicine, Kyung Hee University Hospital at Gangdong, College of Medicine, Kyung Hee University, 05278 Seoul, Republic of Korea

***Correspondence**
suhhyungseok@khu.ac.kr
(Hyungseok Seo)

Abstract

The lightwand is a valuable device for managing the airways of patients with neck immobilization due to its ease of minimal neck movement. For lightwand intubation, adopting a face-to-face technique offers the potential for improved accessibility and reduced risk of injury associated with blind scooping maneuvers. In this study, we compared the initial success rate of the face-to-face approach with the conventional method as the primary endpoint and their complications as the second endpoint, including postoperative sore throat, the incidence of bleeding and hoarseness in neck-immobilized patients. Our findings indicate that the initial success rate was 84.1% for the face-to-face approach and 88.6% for the conventional approach (p = 0.381). The intubation times for the face-to-face approach and conventional approach were 12.0 and 14.0 seconds, respectively (p = 0.704). Furthermore, there were no statistically significant inter-group differences observed in the overall incidence of postoperative complications, including sore throat, bleeding and hoarseness. In summary, our study shows that the face-to-face approach in lightwand intubation for neck-immobilized patients could be suggested as one of the alternatives, yielding outcomes similar to the conventional lightwand technique.

Keywords

Airway management; Difficult airway; Face-to-face intubation; Lightwand; Neck immobilized; Trauma

1. Introduction

Airway management in patients with neck immobilization presents a significant challenge to anesthesiologists, given the need to protect the airway while minimizing the risk of neurologic injuries [1]. In cases involving an unstable cervical spine, the use of direct laryngoscopy for tracheal intubation can potentially exacerbate neurologic injury through cervical spine hyperextension. While awake fiberoptic bronchoscopy (FOB) remains the gold standard for intubation to prevent further neurologic injury, its successful application necessitates clinical expertise [2]. Furthermore, there may be instances, such as in non-operating rooms or emergency settings, where FOB is either unavailable or requires a longer preparation time. In contrast, the lightwand, characterized by a single stylet with an illuminated tip, offers the advantage of easy portability and preparation for intubation [3]. Notably, it also minimizes cervical movement compared to direct laryngoscopy, thereby presenting a valuable option in the clinical management of neck-immobilized patients [4, 5].

For successful lightwand intubation, it is essential to position the lit tip correctly at the glottic opening. The usual way of using the lightwand involves a scooping motion and pushing the patient's lower jaw forward, which could potentially harm the soft tissues in the throat or even injure the larynx [6]. In contrast, the face-to-face technique in lightwand intubation takes a more direct approach, guiding the lightwand along the curve of the tongue base without the scooping motion [7]. This method has been suggested as an alternative for difficult intubations [7, 8]. However, there is a lack of evidence regarding its effectiveness in lightwand intubation for patients with neck immobilization when compared to the traditional approach. Hence, the primary aim of the study is to compare the initial success rate and the secondary aim of the study is to compare complications related to intubation using these two lightwand techniques in neck-immobilized patients.

2. Methods

2.1 Study design

In this prospective randomized single-blinded cohort study, we assessed the initial success rate of the conventional technique with the face-to-face technique in neck-immobilized patients.

2.2 Patients

We included a total of 178 adult participants with American Society of Anesthesiologists physical statuses ranging from 1 to 3, who were scheduled to undergo spinal surgery under general anesthesia. Exclusion criteria were as follows: (1) individuals with a body mass index below 18.5 kg/m^2 or above 35.0 kg/m^2; (2) those with a history of prior head and neck surgery; (3) patients at high risk of aspiration; (4) individuals with airway pathologies such as tumors, polyps, or inflammation; (5) patients unable to sit due to severe spinal deformities; (6) individuals with compromised cardiopulmonary function, defined as experiencing symptoms of dyspnea or chest discomfort during exertion; and (7) patients with clinically significant neurovascular diseases, such as cerebral aneurysms or arteriovenous malformations.

2.3 Allocation, randomization

All included patients were randomized using a computer-generated random assignment table, employing both the random 4-block and 6-block techniques. On the day of surgery, an independent investigator, uninvolved in the anesthesia process, allocated the patients into two groups: Group C, where patients received tracheal intubation using the conventional lightwand technique, or Group F, where patients underwent tracheal intubation using the lightwand with the face-to-face technique. Four anesthesiologists, possessing substantial expertise in lightwand intubation, participated as intubators in the study. Each intubator received a standardized instruction session regarding the face-to-face technique with the Manikin model more than three times before the study and the study protocol. While the intubators were aware of each patient's group assignment, they were not involved in the assessment of study outcomes. Both patients and physicians responsible for evaluating postoperative intubation-related complications remained blinded to the specific intervention throughout the study.

2.4 Anesthesia protocols

The anesthesia management for both groups was standardized, with the exception of the tracheal intubation technique. Upon arrival in the operating room, routine patient monitoring was conducted, encompassing electrocardiogram, peripheral oxygen saturation (SpO_2), bispectral index (BIS), and non-invasive blood pressure monitoring. Anesthesia was induced and maintained through a target-controlled infusion of propofol and remifentanil to maintain a BIS level below 60. Rocuronium bromide (0.6 mg/kg) was administered to facilitate tracheal intubation. To ensure neck immobilization, patients were fitted with cervical neck collars (Miami J, Ossur, Reykjavík, Iceland or Vista®, Aspen Medical Product, Irvine, USA) before anesthesia induction. Alternatively, a manual in-line stabilizing technique was employed throughout the intubation process. The cervical neck collar comprises two parts (anterior and posterior), and the anterior section was temporarily removed immediately before intubation. Most patients had the cervical neck collar in place prior to anesthesia induction, but in cases where it was not prepared, the manual in-line stabilizing technique was implemented throughout the entire intubation procedure. Preoxygenation and manual ventilation with 100% oxygen were performed for 5 to 10 minutes before tracheal intubation in both groups. A lightwand (LIGHT WAY, Ace Medical, Seoul, Korea) with a 90-degree angulation at 5 cm from the tip was utilized in both groups. Tracheal intubation involved the use of a reinforced tube with an inner diameter of 7.0 mm for female patients and 7.5 mm for male patients.

In both groups, two members of the anesthesia team participated: one served as the intubator, while the other was the assistant. In Group C, the intubator used the conventional overhead approach. Briefly describing the conventional lightwand intubation, the patients were in a supine position, and the intubator stood above the patient's head. With one hand, the intubator opened the patient's mouth and gently pulled the mandible, inserting the lightwand-tracheal tube assembly at the midline of the patient's mouth with the ambient light turned off. To locate the position of the illuminated tip, the intubator could gently move the lightwand back and forth. Once the red light from the tip was positioned at the midline of the patient's neck, the pre-loaded tube was smoothly inserted into the patient's airway unless there was any resistance. The assistant typically stood on the left side of the patient, assisting with mandibular protraction or closely observing the procedure. In Group F, the upper portion of the operating bed was elevated approximately 30–40 degrees, and the intubator stood directly facing the patient. The assembly was smoothly inserted at the midline, following the tongue base. Similar to Group C, once the red light from the tip was identified at the midline of the neck, the pre-loaded tube was inserted smoothly. The assistant typically stood alongside the intubator, providing close observation. After successful intubation in both groups, other anesthesia management was provided based on the patient's condition. A radial artery was catheterized to enable continuous arterial pressure monitoring. An additional intravenous route was secured for fluid administration, employing a 16-gauge catheter or central venous catheterization as necessary. For all patients, volume-controlled mechanical ventilation was delivered using an anesthesia machine (Primus®; Dräger, Lübeck, Germany). Ventilatory settings included a tidal volume of 6–8 mL based on ideal body weight, a respiratory rate of 10–16 breaths per minute, and the application of 5 cmH_2O positive end-expiratory pressure to maintain an end-tidal carbon dioxide concentration between 35–40 mmHg.

After the surgery, a fentanyl-based intravenous (IV) patient-controlled analgesia for postoperative pain control was provided, and the patient was extubated smoothly using a remifentanil concentration of 1.0–1.5 ng/mL. No topical lidocaine was applied in both groups. All patients were transferred to the postoperative care unit, and IV acetaminophen (1 g) was provided for postoperative pain control.

2.5 Outcome measurement

Intubation time was defined as the duration between the insertion of the light wand-tracheal tube assembly into the oral cavity and the complete removal of the lightwand from the tube. Both groups adhered to a 90-second limit for each

intubation attempt, with 1-minute mask ventilation intervals between attempts. A maximum of three attempts by the same intubator was allowed in a single patient, after which either a different intubator took over or an alternative technique (*e.g.*, fiberoptic bronchoscopy or video laryngoscopy) was considered.

2.6 Data collection and processing

Data, including intubation attempts, intubator changes, intubation time and any related events, were manually recorded on both the anesthesia note and the individual external documents immediately after intubation by independent observers who did not participate in the study. Blood pressure and heart rate were recorded before and after intubations. Post-surgery assessments involved inspections of the oral cavity and tracheal tube cuff for bleeding. Subsequently, patients were evaluated in the postoperative care unit for the presence of postoperative hoarseness. Sore throat severity was rated on a numerical scale (ranging from 0, indicating no pain, to 10, the most severe pain), categorized as slight (0–3), moderate (4–6) or severe pain (7–10) [9]. Once the data of individuals were finalized, all recorded data were transferred to the Excel spreadsheet before data analysis and de-identified by extracting from the spreadsheet.

2.7 Statistical analysis

The conventional lightwand intubation technique has been previously reported to have an initial success rate of approximately 80% [10]. To detect a statistically significant difference between the two groups, we hypothesized that a minimum difference of 15 percentage points would be necessary. Accordingly, we calculated a sample size of 80 patients per group, with an assumed type I error rate of 0.05 and a desired power of 0.8 for our experimental design. Taking into account a potential 10% loss due to unexpected circumstances, 88 patients per group were recruited. Demographic and preoperative data were subjected to intent-to-treat analysis. Data on the incidence of postoperative complications were analyzed using per-protocol analysis, as the actual number of patients included could influence outcome measurements. The normality of the data was assessed using the Shapiro-Wilk test. Continuous data were analyzed using either the Student's *t*-test or the Mann-Whitney U test, depending on the data distribution. Categorical data were assessed using chi-squared analysis or Fisher's exact test when applicable. Statistical analyses were conducted using standard statistical software (MedCalc®; MedCalc Software, version 22.016, Ostend, Belgium). All values were presented as mean ± standard deviation, median (interquartile range), or number (percentage). Statistical significance was defined as $p < 0.05$.

3. Results

A total of 178 adult patients were enrolled and randomly allocated into two Groups (Fig. 1), and comparative analysis showed no significant demographic differences between Group C and F (Table 1).

The initial success rate in Group F was 84.1%, while it was 88.6% in Group C ($p = 0.381$). The median intubation time in Group F was 12.0 seconds, slightly shorter but not statistically significant compared to Group C (14.0 seconds, $p = 0.704$) (Table 2). In Group C, three unsuccessful cases were eventually intubated after multiple attempts lasting more than 4 minutes or using video laryngoscopy. Among the three failed cases in Group F, two were successfully intubated after changing the intubator, and the remaining one was intubated using the conventional technique.

The intubation-related complications are shown in Table 3, showing no statistical differences between Group C and F. In Group F, the immediate and 24-hour post-anesthesia incidence of sore throat was 26.1% and 9.4%, respectively (compared to 20.5% and 6.8% in Group C). The incidence of hoarseness in Group F was 1.1% immediately after anesthesia and 4.7% 24 hours after anesthesia (compared to 4.5% and 1.1% in Group C, respectively). The severity of sore throat is shown in Fig. 2, revealing a similar reduction in sore throat intensity 24 hours after anesthesia in both Group C and F.

4. Discussion

In this study, we conducted a comparative analysis of the initial success rate associated with two distinct lightwand intubation techniques in patients with neck immobilization. Our findings demonstrated that the face-to-face approach in lightwand intubation yielded comparable outcomes to the conventional approach without an increase in intubation-related complications. Despite the lightwand is an old-fashioned device and even the face-to-face approach in lightwand techniques compared to the conventional method is unfamiliar to be used in general practice, our study highlights its potential as a clinically effective alternative for airway management in patients with neck immobilization.

Previous studies have explored the face-to-face approach in airway management using video laryngoscopy or simulated scenarios [8, 11–13]. Notably, the lightwand stands out due to its compact, slender design and the flexibility of its lighted tip, allowing for easy adaptation to a patient's airway anatomy [14]. Unlike FOB, the lightwand offers cost-effectiveness, greater portability and minimal reliance on specialized equipment. Thus, it has emerged as a valuable tool for managing challenging airways, especially in patients with trauma or cervical spine instability [14, 15]. Its adaptability enables straightforward customization to access the airway from various angles, including the face-to-face approach.

In patients with neck immobilization, direct laryngoscopy is often viewed as a last-resort option for tracheal intubation to avoid neck extension. However, alternative techniques such as the lightwand, video laryngoscope or FOB could also be considered. Despite being an older and blind technique that is commercially unavailable in some regions, lightwand intubation offers several advantages due to its compact size, semi-rigidity, adjustable tip angle and ease of use [16], which is especially valuable in patients with limited mouth opening or spinal deformities, where performing awake FOB can be challenging due to its availability or bleeding risks [2, 17]. Furthermore, video laryngoscopy, theoretically involving similar cervical spine movements as direct laryngoscopy, retains

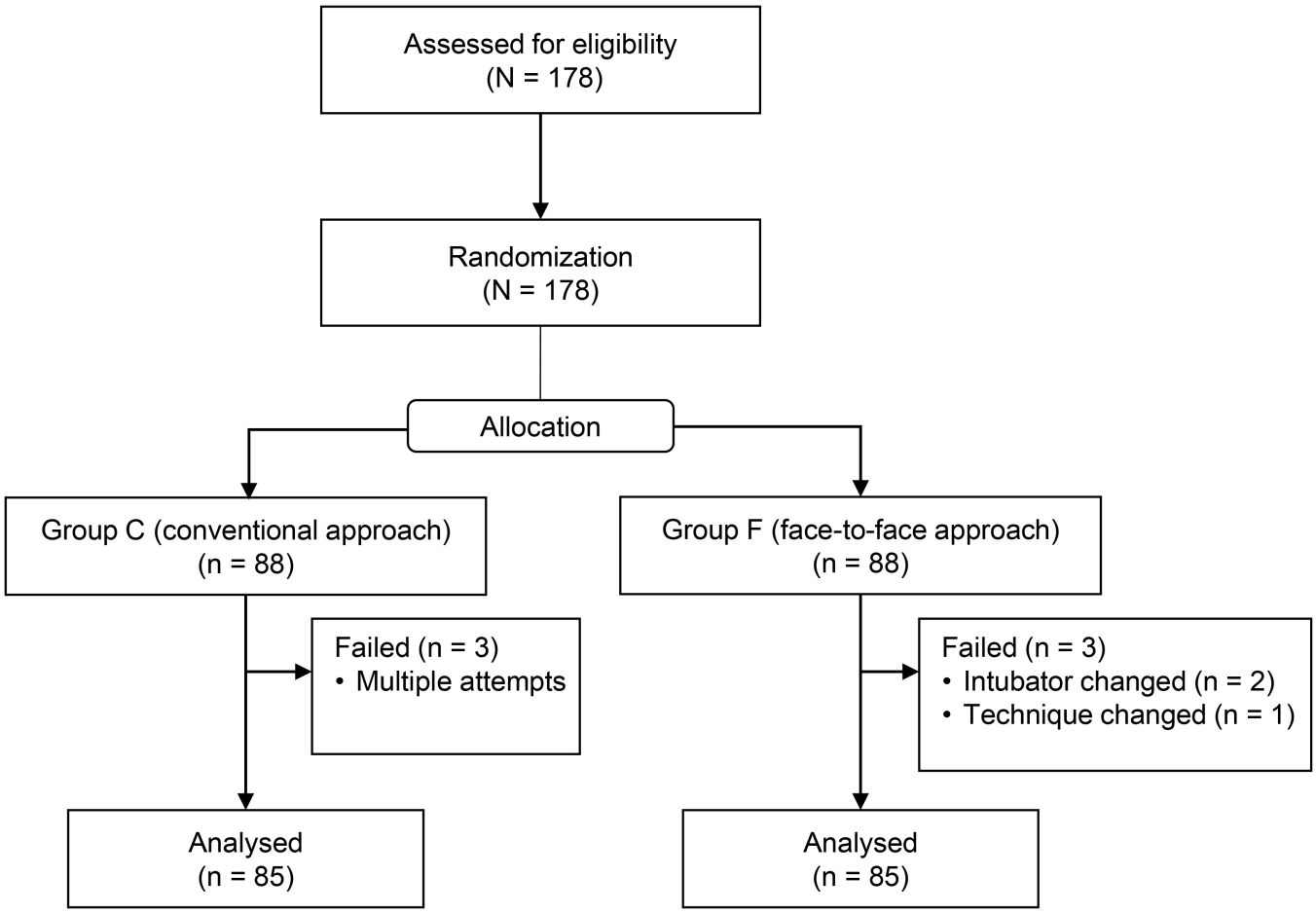

FIGURE 1. The CONSORT flowchart.

TABLE 1. Demographics of the study population.

Variables	Group C (n = 88)	Group F (n = 88)	*p*
Age (yr)	68 (58–76)	66 (55–74)	0.243
Sex (Male:Female)	27:61	42:46	0.021
Height (cm)	155.7 (150.0–164.0)	159.9 (152.5–170.0)	0.050
Weight (kg)	61 (54–70)	65 (56–74)	0.079
ASA PS (1/2/3)	24 (27%)/53 (60%)/11 (13%)	28 (32%)/54 (61%)/6 (7%)	0.409

All data are expressed by median (interquartile range) or number (%); ASA PS: American Society of Anesthesiologists Physical Status.

TABLE 2. Intubation profiles between Group C and Group F.

Variables	Group C (n = 85)	Group F (n = 85)	*p*
Intubation attempt (n)	1 (1–1)	1 (1–1)	0.327
Initial success rate (n, %)	78, 88.6%	74, 84.1%	0.381
Intubation time (sec.)	13.4 (7.0–27.0)	11.5 (7.0–19.5)	0.734
Intubation failure (n, %)	3, 3.4%	3, 3.4%	1.000

All data are expressed as median (interquartile range) or number (%).

TABLE 3. Intubation-related complications between Group C and Group F.

Variables	Group C (n = 88)	Group F (n = 88)	*p*
Bleeding			
Intraoral (n, %)	3, 3.4%	1, 1.1%	0.621
Blood-tinged cuff (n, %)	2, 2.5%	3, 4.5%	0.660
Sore throat			
Immediately after anesthesia (Post-anesthesia care unit)			
Overall (n, %)	18, 20.5%	23, 26.1%	0.374
No pain	70, 79.5%	65, 73.9%	0.372
Slight pain	12, 66.7%	19, 82.6%	0.166
Moderate pain	4, 22.2%	4, 17.4%	1.000
Severe pain	2, 11.1%	0, 0%	0.155
24 hours after anesthesia (At ward)			
Overall (n, %)	6, 6.8%	8, 9.4%	0.533
No Pain	82, 93.2%	80, 90.6%	0.577
Slight pain	5, 83.3%	8, 100%	0.387
Moderate pain	1, 16.7%	0, 0%	0.316
Severe pain	0, 0%	0, 0%	N/A
Hoarseness			
Immediately after anesthesia (n, %)	4, 4.5%	1, 1.1%	0.368
24 hours after anesthesia (n, %)	1, 1.1%	4, 4.7%	0.205

All data are expressed by median (interquartile range) or number, %.
N/A: Non applicable.

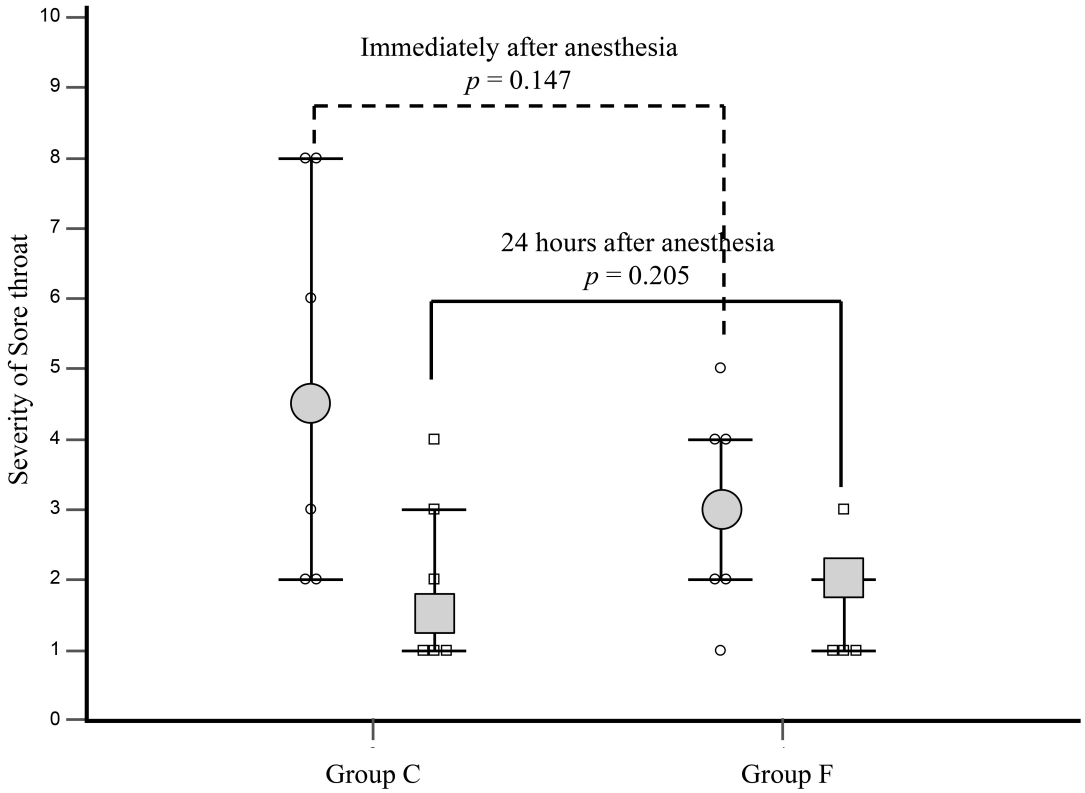

FIGURE 2. Changes in the severity of sore throat between Group C and Group F (Grey circle/square: the median value; the upper/lower bar: interquartile range).

a risk of neurological injury [18]. Despite its lower specificity in identifying the glottic opening compared to video laryngoscopy or FOB, the blind technique of the lightwand allows for multi-directional approaches, is less affected by soft tissue bleeding, and does not necessitate additional equipment such as monitors or light sources. Therefore, it can be considered a viable alternative for airway management, especially when video laryngoscopy is readily available.

Compared with the conventional approach, the initial success rate was anticipated to be lower in the face-to-face approach due to its unfamiliarity. However, the comparatively simplified manipulation with reduced mandibular protraction or scooping movements may have contributed to the similarity in our results. Furthermore, while we initially expected a lower incidence or intensity of sore throat as an intubation-related outcome with the face-to-face approach, our findings did not support this hypothesis. Despite the face-to-face approach being an uncommon technique in lightwand intubation, our study showed its usability compared to the conventional approach. Considering the diverse clinical scenarios that can occur during airway management in both emergency and elective surgeries [8, 11], improving patient safety by incorporating multiple techniques tailored to specific situations is recommended.

Our study has several limitations. Firstly, the limited number of intubators could impact the generalizability of our findings. While we assigned patients randomly to intubators, some intubators handled more than 20 cases in each group throughout the study duration. Although the face-to-face approach may have been initially unfamiliar to the intubators, as the study progressed, they might have become more adept with the technique, potentially influencing the initial success rate. Results may differ with less experienced or novice airway practitioners. Thus, when it comes to the novice or practitioners unfamiliar with lightwand, the face-to-face technique should be considered under supervision. Secondly, the availability of the lightwand device varies by country and institution. While it was accessible during our study period, its availability may differ depending on clinical circumstances and the healthcare institution. Because of this limited availability of the lightwand, our result cannot be helpful or applied in institutions where the lightwand is not already used. Furthermore, we did not conduct a comprehensive preoperative airway evaluation. Although we excluded major airway issues during patient enrollment, a detailed preoperative airway assessment could aid in predicting airway difficulty and identifying factors that positively or negatively contribute to successful lightwand intubation.

5. Conclusions

In conclusion, compared with the conventional approach of lightwand intubation, the face-to-face approach yielded comparable results in terms of the initial success rate and intubation time without an increase in complications in patients with neck immobilization. The face-to-face approach in lightwand intubation may be suggested as an alternative option for the intubators who are unable to view with the conventional approach.

AVAILABILITY OF DATA AND MATERIALS

The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

AUTHOR CONTRIBUTIONS

KHM—prepared the study, curated data and wrote the original draft. HS—provided study conceptualization, methodology and data analysis; supervised the entire study; reviewed and edited the manuscript. All authors read and approved the final manuscript.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

The present study was ethically approved by the Institutional Review Board of Kyung Hee University Hospital at Gangdong (approval number: KHNMC 2018-10-011-002) and registered in the clinical research registry (NCT06119360) prior to patient enrollment. Written informed consent was obtained from all participants before study inclusion.

ACKNOWLEDGMENT

Not applicable.

FUNDING

This research received no external funding.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

REFERENCES

[1] Wiles MD. Airway management in patients with suspected or confirmed traumatic spinal cord injury: a narrative review of current evidence. Anaesthesia. 2022; 77: 1120–1128.

[2] Eduardo Lema F, Henry M, Claudia G, Carlos Eduardo H, Luis Alberto TB. Guidelines for intubation under fiberoptic bronchoscopy in a university hospital. Colombian Journal of Anesthesiology. 2012; 40: 60–66.

[3] Apfelbaum JL, Hagberg CA, Connis RT, Abdelmalak BB, Agarkar M, Dutton RP, *et al.* 2022 American society of anesthesiologists practice guidelines for management of the difficult airway. Anesthesiology. 2022; 136: 31–81.

[4] Epaud A, Levesque E, Clariot S. Dramatic cervical spine injury secondary to videolaryngoscopy in a patient suffering from ankylosing spondylitis. Anesthesiology. 2021; 135: 495–496.

[5] Turkstra TP, Craen RA, Pelz DM, Gelb AW. Cervical spine motion: a fluoroscopic comparison during intubation with lighted stylet, glidescope, and macintosh laryngoscope. Anesthesia & Analgesia. 2005; 101: 910–915.

[6] Hong KY, Lee JE, Hwang HJ, Sim WS, Park HJ, Lee JY. Evaluation of factors affecting illumination intensity in lightwand endotracheal intubation. In Vivo. 2024; 38: 490–495.

[7] Jeong H, Chae M, Seo H, Yi J, Kang J, Lee B. Face-to-face intubation using a lightwand in a patient with severe thoracolumbar kyphosis: a case report. BMC Anesthesiology. 2018; 18: 92.

[8] Venezia D, Wackett A, Remedios A, Tarsia V. Comparison of sitting face-to-face intubation (two-person technique) with standard oral-tracheal intubation in novices: a mannequin study. The Journal of Emergency Medicine. 2012; 43: 1188–1195.

[9] Pace AK, Bruceta M, Donovan J, Vaida SJ, Eckert JM. An objective pain score for chronic pain clinic patients. Pain Research and Management. 2021; 2021: 6695741.

[10] Harvey K, Davies R, Evans A, Latto IP, Hall JE. A comparison of the use of Trachlight® and Eschmann multiple-use introducer in simulated difficult intubation. European Journal of Anaesthesiology. 2007; 24: 76–81.

[11] Nowak-Tim J, Gaszynski T, Ratajczyk P. A comparison of face-to-face endotracheal intubation and standard intubation using Airtraq video laryngoscope in morbidly obese patients: a randomized controlled trial. Medicine. 2022; 101: e32046.

[12] Ynineb Y, Boglietto E, Bonnet F, Quesnel C, Garnier M. Face-to-face double-lumen tube intubation with the Airtraq video laryngoscope for emergency thoracic surgery: a case report. Seminars in Cardiothoracic and Vascular Anesthesia. 2022; 26: 90–94.

[13] Julliard D, Vassiliadis J, Bowra J, Gillett M, Knipp R, Krishnamohan A, *et al*. Comparison of supine and upright face-to-face cadaver intubation. The American Journal of Emergency Medicine. 2022; 56: 87–91.

[14] Yang K, Jeong CH, Song KC, Song JY, Song J, Byon H. Comparison between glidescope and lightwand for tracheal intubation in patients with a simulated difficult airway. Korean Journal of Anesthesiology. 2015; 68: 22.

[15] Massó E, Sabaté S, Hinojosa M, Vila P, Canet J, Langeron O. Lightwand tracheal intubation with and without muscle relaxation. Anesthesiology. 2006; 104: 249–254.

[16] Ge X, Liu W, Zhang Z, Xie F, Zhao T, Li Y. Evaluation of lightwand-guided endotracheal intubation for patients with missing or no teeth: a randomized controlled study. Brazilian Journal of Anesthesiology. 2021; 71: 395–401.

[17] Sheet J, Mandal A, Sengupta S, Jana D, Mukherji S, Swaika S. Anaesthetic management in a case of huge plunging ranula. Anesthesia: Essays and Researches. 2014; 8: 114.

[18] Dutta K, Sriganesh K, Chakrabarti D, Pruthi N, Reddy M. Cervical spine movement during awake orotracheal intubation with fiberoptic scope and McGrath videolaryngoscope in patients undergoing surgery for cervical spine instability: a randomized control trial. Journal of Neurosurgical Anesthesiology. 2020; 32: 249–255.

How to cite this article: Kyeong-Hyeon Min, Hyungseok Seo. Comparison of lightwand intubation technique in neck-immobilized patients with face-to-face and conventional approaches. Signa Vitae. 2024. doi: 10.22514/sv.2024.065.