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ORIGINAL RESEARCH

Comparison of conventional versus channeled blade in tracheal intubation using video laryngoscope: a prospective randomized controlled trial

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Abstract

Background: During tracheal intubation using video laryngoscopy, manipulating the tracheal tube may be challenging because of misalignment between the camera's visual axis and the curvature of the tube, which can hinder smooth tube advancement and potentially increase the risk of airway trauma. A channeled laryngoscope blade, which allows the tube to be preloaded and guided directly along the visual axis, may facilitate easier intubation and reduce soft tissue injury, thereby offering a potential advantage over conventional blades. This study compared the performance of channeled and conventional blades for tracheal intubation using video laryngoscopy. **Methods**: In this prospective randomized controlled trial, 140 adult patients undergoing elective spine surgery were randomly assigned to intubation with either a conventional blade (Group Co) or a channeled blade (Group Ch). The primary outcome was the intubation time, measured from the insertion of the laryngoscope to confirmation of successful tracheal intubation. Secondary outcomes included the initial intubation success rate and intubation-related complications, such as bleeding, sore throat, and hoarseness. **Results**: Baseline characteristics were comparable between the two groups. The median intubation time was longer in Group Ch (20.7 s) than in Group Co (19.5 s, $p = 0.008$). However, the initial success rate and the incidence of intubation-related complications were similar between the two groups. **Conclusions**: The channeled blade was associated with a slightly longer intubation time but demonstrated a similar success rate and safety profile compared to the conventional blade. Both blade types showed comparable clinical performance, suggesting that the choice between them may be guided by operator preference. **Clinical Trial Registration**: NCT04948294, retrospectively registered.

Keywords

Intubation; Video laryngoscopy; Channeled blade; Intubation time

1. Introduction

Video laryngoscopy (VL) is widely preferred for airway management because of its ability to provide an improved view of the glottis and to increase the success rate of tracheal intubation [1]. However, because the camera is positioned at the tip of the device, the visual axis often does not align with the natural curvature of the tracheal tube, making tube advancement more difficult. Moreover, as the intubator primarily focuses on the video monitor rather than directly visualizing the airway, improper tube steering may occur, potentially leading to complications, such as sore throat, subglottic injury, or pharyngeal bleeding [2].

Compared with conventional non-channeled blades, channeled blades allow the tracheal tube to be preloaded and guided along the camera's line of sight, potentially reducing the need for manipulation and minimizing soft tissue injury. However, the fixed path of the tube within the channel may limit flexibility during final advancement through the glottis [3].

In this study, we hypothesized that intubation performance may differ between conventional and channeled blades when using VL for tracheal intubation. Therefore, we designed this prospective randomized controlled trial to compare the intubation time of conventional and channeled blades.

2. Materials and methods

2.1 Study design

The study was approved by the Institutional Review Board of Kyung Hee University Hospital at Gangdong (approval number: KHNMC 2019-07-020-001) and was registered in the clinical research registry before patient enrollment (NCT04948294). The trial was conducted between February and July 2020, and written informed consent was obtained

from all participants before study inclusion.

2.2 Patients

A total of 140 adults with an American Society of Anesthesiologists (ASA) physical status of I–III, scheduled for elective spinal surgery under general anesthesia, were considered for this study. The exclusion criteria were: (1) body mass index <18.5 kg/m^2 or >35.0 kg/m^2; (2) prior head and neck surgery; (3) high risk of aspiration; and (4) airway pathologic conditions, such as tumors, polyps, or inflammation.

2.3 Allocation, randomization, and blindness

All enrolled patients were randomized using a computer-generated random assignment table and a random 4-block technique. The patients were allocated to either the conventional blade group (Group Co) or the channeled blade group (Group Ch) on the day of surgery by an independent investigator who did not participate in the anesthesia procedure. Tracheal intubation was performed by experienced staff anesthesiologists who were familiar with both types of blades and were not involved in the outcome assessment. The patients and the physicians who assessed postoperative intubation-related complications were blinded to the group assignment.

2.4 Anesthesia protocols

Anesthesia management, except for the tracheal intubation technique, was standardized for both groups. Upon arrival in the operating room, standard patient monitoring was performed, including electrocardiography, peripheral oxygen saturation (SpO_2), bispectral index (BIS), and noninvasive blood pressure monitoring. Anesthesia was induced and maintained with target-controlled infusions of propofol and remifentanil to maintain a BIS of <60. Rocuronium bromide (0.6 mg/kg) was administered to facilitate tracheal intubation. Before intubation, preoxygenation and manual ventilation were performed for 5–10 min with 100% oxygen in both groups, and all tracheal intubations were performed after confirming a train-of-four count of zero.

All intubations were performed using the same video laryngoscope (AceScope™, Ace Medical, Seoul, Korea) with either a conventional or a channeled single-use blade. The AceScope™ is a video laryngoscope that uses a standard-geometry Macintosh-type blade. In all intubation cases, a size #3 blade was used. The channeled blade has an effective length of 13.3 cm, which is the same as the non-channeled blade, but it has a small projected wing for guiding the tracheal tube (Fig. 1). In Group Co, the intubator used the video laryngoscope with a conventional non-channeled blade, whereas in Group Ch, the tracheal tube was preloaded into the blade channel before intubation. An assistant handed the tracheal tube or the tube-loaded video laryngoscope to the intubator but did not assist with intubation unless the initial attempt failed. Tracheal tubes with an internal diameter of 7.0 mm were used in females and 7.5 mm in males. Successful intubation was confirmed by the presence of an end-tidal carbon dioxide curve.

2.5 Outcome measurement

Intubation time was defined as the interval from picking up the video laryngoscope to the time at which the tracheal tube cuff completely passed the vocal cords. Each intubation attempt was limited to 90 s or until SpO_2 dropped below 90%, and one-minute mask ventilation was provided between attempts. The intubator was allowed a maximum of three attempts per patient. If the third attempt failed, the case was recorded as a failure, and an alternative intubation technique was employed (such as using a stylet, changing the intubator, or using fiberoptic bronchoscopy). After extubation, the oral cavity and the tracheal tube cuff were inspected for any bleeding, and all patients were assessed in the postoperative care unit (PACU) for the presence of postoperative sore throat and hoarseness.

2.6 Statistical analysis

A pilot study showed that the intubation time using a conventional blade and a channeled blade was 20.2 $\pm$ 2.5 s and 23.7 $\pm$ 8.1 s, respectively. Based on these results, we calculated the sample size needed to detect a statistically significant difference between the two groups. Sixty-four patients per group were required, assuming a type I error of 0.05 and a desired power of 0.8. Considering a potential 10% loss due to unexpected circumstances, we recruited 70 patients per group. The demographic and preoperative data were compared using intent-to-treat analyses, whereas data regarding the incidence of postoperative complications were calculated using per-protocol analysis because the actual number of analyzed patients can affect the outcome values. The Shapiro-Wilk test was used to assess the normality of the data. Continuous data were analyzed using the Student's *t*-test or the Mann-Whitney U test, depending on normality. Categorical data were analyzed using chi-squared analysis or Fisher's exact test when applicable. Statistical analyses were performed using a standard statistical program (23.4.0, MedCalc®; MedCalc Software, Ostend, Belgium). All values are expressed as mean $\pm$ standard deviation, median (interquartile range), or number (percentage), and statistical significance was set at $p < 0.05$.

3. Results

One hundred and forty adult patients were enrolled and randomly assigned to the two groups (Fig. 2). Data analysis showed no significant demographic differences between the two groups (Table 1), and the proportion of patients with potentially difficult intubation (Cormack-Lehane grade $\geq$3) was similar in both groups. In addition, there were no cases of intubation failure.

Intubation profiles for Group Co and Group Ch are shown in Table 2. The number of intubation attempts was similar in both groups. However, the median intubation time was significantly longer in Group Ch (20.7 s) than in Group Co (19.5 s, p = 0.008) (Fig. 3). The initial success rates were 92% in Group Co and 86% in Group Ch (p = 0.233).

Intubation-related complications did not differ significantly between the two groups (Table 3), with the incidences of

FIGURE 1. The channeled and conventional blade of AceScope™. The channeled blade (left) and the conventional blade (right) of AceScope™. The channeled blade has the same design as the conventional blade (non-channeled). Both blades are size #3, Macintosh-type curved blades.

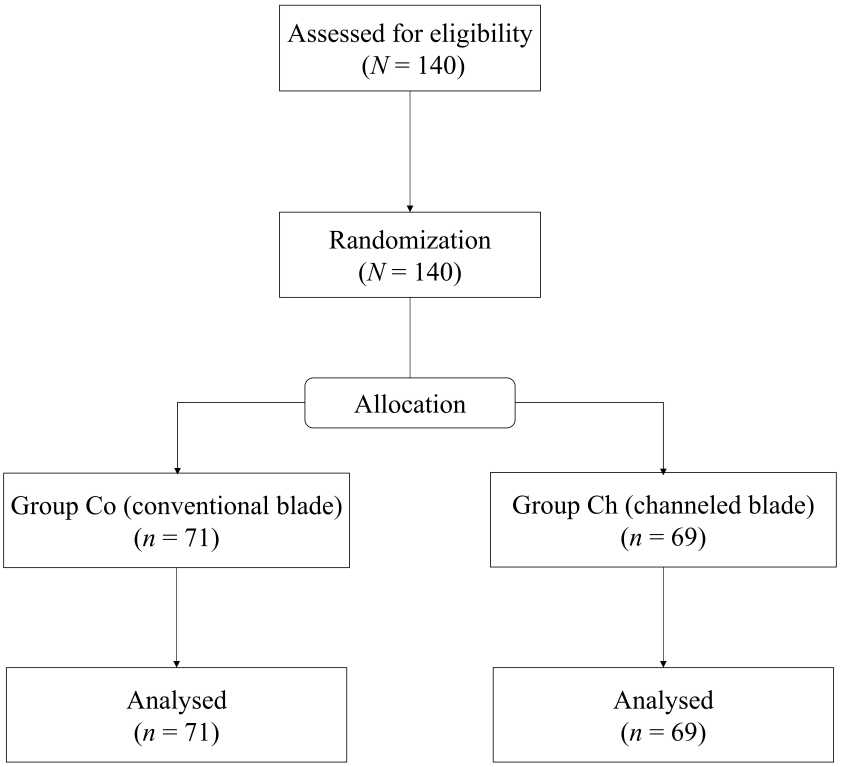

FIGURE 2. CONSORT flowchart for patient selection.

TABLE 1. Patients' demographics.

Variables	Group Co (n = 71)	Group Ch (n = 69)	*p*
Age (yr)	51 [41–63]	49 [42–63]	0.767
Sex (Male:Female)	22:49	28:41	0.238
Height (cm)	160.0 [157.1–168.7]	160.5 [156.6–169.0]	0.940
Weight (kg)	62.2 [56.3–70.6]	63.5 [56.8–74.7]	0.524
ASA PS			
1	32 (45%)	29 (42%)	0.721
2	31 (44%)	34 (49%)	0.555
3	8 (11%)	6 (9%)	0.695
C-L Grade			
1, 2 (n, %)	64 (90%)	60 (88%)	0.706
≥3 (n, %)	7 (10%)	9 (6%)	0.664

The data are expressed as median [interquartile range] or number (%).
ASA PS: American Society of Anesthesiologists Physical Status; C-L Grade: Cormack-Lehane Grade.

TABLE 2. Intubation profiles between Group Co and Group Ch.

Variables	Group Co (n = 71)	Group Ch (n = 69)	*p*
Intubation attempt			
1 (n, %)	65 (92%)	59 (86%)	0.233
2 (n, %)	6 (8%)	9 (13%)	0.158
3 (n, %)	0 (0%)	1 (1%)	0.400
Initial success rate (n, %)	65 (92%)	59 (86%)	0.233
Intubation time (s)	20 [18–21]	21 [20–23]	0.008

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

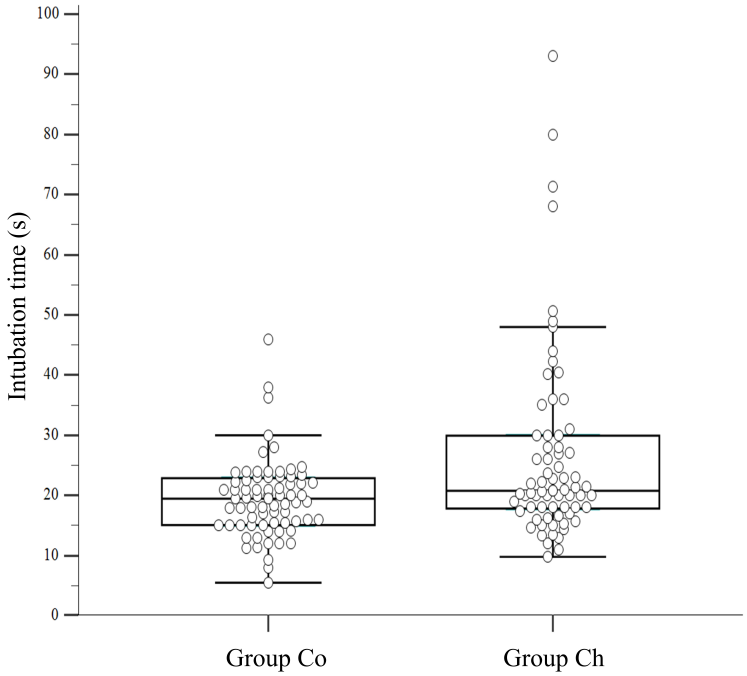

FIGURE 3. Intubation time between the two groups. Intubation time was shorter in Group Co than in Group Ch. (Each small circle indicates an individual value, the middle bar indicates the median value, and the upper and lower bars indicate the interquartile range).

TABLE 3. Intubation-related complications between Group Co and Group Ch.

Variables	Group Co (n = 71)	Group Ch (n = 69)	*p*
Bleeding (n, %)			
Intraoral bleeding	1, 1.4%	1, 1.4%	0.984
Blood-tinged cuff	4, 5.6%	5, 7.2%	0.842
Sore throat at PACU (n, %)	34, 48%	37, 54%	0.499
Hoarseness at PACU (n, %)	34, 48%	40, 58%	0.193

All data are expressed as number (%).
PACU: post-anesthesia care unit.

bleeding being 7.0% in Group Co and 8.6% in Group Ch (p = 0.984), and the incidence rates of sore throat and hoarseness in the PACU also being comparable between the two groups.

4. Discussion

In the present randomized controlled trial, the intubation time was longer when a channeled blade was used, although the initial success rate and intubation-related complications did not differ significantly between the two types of blades.

VL provides a better laryngeal view and facilitates tracheal intubation [4, 5]. However, the intubator's focus on the monitor, rather than directly viewing the passage of the tracheal tube, may make tube advancement more challenging and increase the risk of soft tissue injury [6]. Theoretically, a channeled blade should make intubation easier because it requires less manipulation of the tracheal tube and largely eliminates the "blind" phase while the tube passes through the oropharynx, which may provide more controlled conditions for tube advancement and reduce soft tissue injury. However, since the tube must follow the fixed curvature of the channel rather than being freely adjusted by the intubator, fine directional corrections near the glottis can be more difficult, which may partly explain the longer intubation times observed in this study.

Previous studies on patients with cervical collars or undergoing emergency surgery have reported comparable performances between channeled and conventional blades [3, 7]. Although some studies have shown faster intubation with channeled blades, variations in video laryngoscope design, intubator experience, and experimental settings (for example, mannequin-based studies) may account for these inconsistent results [8–10]. Our findings are consistent with a recent systematic review indicating that the conventional blade is superior in terms of the initial success rate of tracheal intubation [11].

Our findings suggest that the channeled blade performs similarly to the conventional blade during tracheal intubation using VL. The slightly longer intubation time observed with the channeled blade (approximately one second) appears to have limited clinical significance. Although the results show a statistical significance, a difference of one second can be considered negligible and is generally regarded as indicating similar clinical performance. Moreover, although VL provides better visualization of the glottis, it does not guarantee easy tube passage, and the clinical skill and experience of the intubator contribute substantially to successful intubation. Our results showed that the channeled blade achieved an initial success rate of 86.5% compared with 92% for the conventional blade, and while this difference was not statistically significant, the fact that the channeled blade aligns the tube with the camera may limit tube manipulation during insertion. The anatomy of the tracheal wall, which passes posterior to the tracheal axis, can lead to collisions with the tip of the tracheal tube, and, in the case of the channeled blade, the anterior bending of the tracheal tube is fixed, which can result in difficulty redirecting the tube and may increase the chance of impingement on the arytenoids or the anterior commissure of the vocal cords [12–14]. Taken together, both types of blades can provide similar performance in tracheal intubation, and the intubator can choose either type of blade depending on their experience and preferences.

The present study has some limitations. As a single-center study with a relatively small number of intubators, the external validation of the results may be limited, and even if all intubators are assumed to be skilled and standardized, variations in individual intubation skills may still exist. Since VL is currently regarded as the first choice for tracheal intubation and the present study was performed quite a while ago, the generalizability and skill in using VL may differ. Second, patients with anticipated difficult airways and other airway management risks were excluded to ensure that the results were not influenced by these factors; however, given that VL can be utilized more frequently in patients with morbid obesity or difficult airways, the mechanics of the channeled blade may offer some advantages or disadvantages in these patients. A further study comparing the two types of VL blades in patients with difficult airways could provide more detailed information for the application of a specific blade and contribute to improving patient safety. Additionally, we investigated the incidence of bleeding, sore throat, and hoarseness only in the PACU, and because adverse events or complications can be observed within 24 hours after intubation, the lack of follow-up beyond 24 hours may have led to an underestimation of the incidence of intubation-related complications [15].

5. Conclusions

Despite the slightly longer intubation time, tracheal intubation using a channeled blade with a video laryngoscope shows

performance that is comparable to tracheal intubation using a conventional blade. Both blade types can, therefore, be appropriately selected based on the intubator's preference, while taking into account the clinical situation and patient characteristics.

AVAILABILITY OF DATA AND MATERIALS

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

AUTHOR CONTRIBUTIONS

HH—prepared the manuscript, curated the data, and wrote the original draft. HS—provided the study's conceptualization, methodology, and data analysis; supervised the entire study; reviewed and edited the manuscript. Both authors have read and approved the final version of the manuscript.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This study was approved by the Institutional Review Board of the Kyung Hee University Hospital in Gangdong (approval number: KHNMC 2019-07-020-001). Written informed consent was obtained from all participants before their inclusion in the study.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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