Original Article

Video versus direct laryngoscopy on successful first-pass endotracheal intubation in ICU patients

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BACKGROUND: Airway management in intensive care unit (ICU) patients is challenging. The aim of this study was to compare the rate of successful first-pass intubation in the ICU by using the direct laryngoscopy (DL) and that by using the video laryngoscopy (VL).

METHODS: A randomized, non-blinded trial comparing first-pass success rate of intubation between VL and DL was performed. Patients were recruited in the period from August 2014 to August 2016. All physicians working at ICU received hands-on training in the use of the video and direct laryngoscope. The primary outcome measure was the first-pass intubation success.

RESULTS: A total of 163 ICU patients underwent intubation during the study period (81 patients in VL group and 82 in DL group). The rate of successful first-pass intubation was not significantly different between the VL and the DL group (67.9% vs. 69.5%, P=0.824). Moreover, the overall intubation success and total number of attempts to achieve intubation success did not differ between the two groups. In patients with successful first-pass intubation, the median duration of the intubation procedure did not differ between the two groups. The Cormack-Lehane grades and the percentage of glottic opening score were similar, and no significant differences were found between the two groups. There were no statistical differences between the VL and the DL group in intubation complications (all P>0.05).

CONCLUSION: Among ICU patients requiring intubation, there was no significant difference in the rate of successful first-pass intubation between VL and DL.

KEY WORDS: Intubation; Video laryngoscopy; Direct laryngoscopy; Intensive care unit

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INTRODUCTION

Airway management in intensive care unit (ICU) patients is challenging.[1] Hypoxemia is common in patients in the ICU requiring intubation, which must be performed rapidly to avoid aspiration because the patient is usually not in a fasted state.[2] Studies have assessed interventions such as routine neuromuscular blockade to improve intubation success rates.[3] Nevertheless, intubation in the ICU still carries higher morbidity and mortality rates compared with intubation in the operating room.[4]

For the past several decades, endotracheal intubation has been performed using the Macintosh laryngoscope for direct laryngoscopy (DL).[5] The video laryngoscope is a recently developed device that contains a miniaturized camera towards the tip of the blades to indirectly visualize the glottis.[6] The video laryngoscopy (VL) is designed to improve the success rate of the physical act of endotracheal intubation, and it has been demonstrated to have utility in anesthesiology practice. By improving glottis visualization, the VL could help to decrease difficult intubation and reduce complications related to intubation in the ICU.[7,8] However, its use in the ICU is more frequent than in operative rooms and its effectiveness in increasing first-pass success and reducing difficult endotracheal intubation or complications related to intubation remain controversial.[9] The aim of this study was to compare the rate of successful first-pass intubation in the ICU by using the DL and that by using the VL in Chinese population.

METHODS

Study design

The present study performed a preliminary, randomized, non-blinded trial comparing first-pass success rate of endotracheal intubation between VL (Med. Adult type Video Laryngoscope VL300M, Zhejiang UE Medical Corp., China) and conventional DL. Patients were recruited in the period from August 2014 to August 2016 at the First Affiliated Hospital of Nanjing Medical University (Nanjing, China).

Inclusion criteria were ICU admission and need for endotracheal intubation to allow mechanical ventilation. Exclusion criteria were: (1) contraindications to endotracheal intubation (e.g., unstable spinal lesion); (2) age younger than 18 years; (3) currently pregnant or breast feeding. The study protocol was reviewed and approved by the Institutional Review Boards for Human Studies of Nanjing Medical University.

Interventions

All physicians working at ICU received hands-on training in the use of the video laryngoscope and conventional (direct) laryngoscope. And all the physicians involved had either worked at ICUs for at least 5 years or worked at ICUs for at least 1 year after receiving at least 2 months of anesthesiology training. Endotracheal intubation was performed according to the standard protocol. Preoxygenation was achieved using the device chosen by the bedside physician according to the standard ICU protocol, including a bag valve mask delivering oxygen at a flow of 10 L/minute or greater for at least 3 minutes. Graded intravenous sedation without neuromuscular blocking agents was used to achieve optimal intubation conditions. The most commonly utilized sedative was propofol. Etomidate, midazolam, and fentanyl were used when propofol was unavailable or contraindicated.

Laryngoscopy was performed using the device allocated at random (i.e., either a VL which had a requirement to obtain indirect glottis visualization via the camera for the first-pass and had a curved blade similar to the direct laryngoscope, or the DL), the intubation technique with VL is similar to that with DL. Endotracheal tube position was confirmed by analyzing the normal-appearing waveform of the partial pressure of end-tidal exhaled carbon dioxide curve over 4 or more breathing cycles.[10] After tube insertion, the cuff was inflated and the tube was connected to the ventilator. Each introduction of the laryngoscope into the oral cavity was considered a separate laryngoscopy attempt. First-pass success was defined as the successful placement of an endotracheal tube on the first intubation attempt. If the first-pass intubation attempt failed, repeat laryngoscopy was performed.

Study outcomes

The primary outcome measure was the first-pass success. Other outcomes included: (1) the overall intubation success (the proportion of patients with successful intubation within 3 attempts); (2) total time to successful intubation (time from anesthesia induction initiation to confirmation of good tube position based on partial pressure of end-tidal exhaled carbon dioxide); (3) glottis view as measured by Cormack-Lehane grade [score range from 1 (good) to 4 (no glottis visualization)] and percentage of glottic opening scale score[11] [score range from 100% (good) to 0% (no glottis visualization)]; (4) difficult intubation (intubation requiring 3 or more attempts, or a total intubation duration longer than 10 minutes, or both);[12] (5) complications [death, cardiac arrest, severe cardiovascular collapse (systolic blood pressure <90 mmHg)], hypoxemia [oxygen saturation by pulse oximeter (SpO_2) <90%] or severe hypoxemia (SpO_2 <80%), esophageal intubation, aspiration, arrhythmia (ventricular tachycardia, ventricular fibrillation, ventricular premature beats), and dental injury.

Statistical analysis

Continuous variables were expressed as the mean±standard deviation (SD) or median with interquartile ranges (IQR), as appropriate. Comparisons of continuous variables between independent groups were performed using the two sample *t* test or Mann-Whitney *U* test, as appropriate. Categorical variables were given as frequencies and percentages. Comparisons of categorical variables were performed by the chi-square test or Fisher's exact test, as indicated. All the statistical tests were performed in SPSS version 16.0 (SPSS Inc., Chicago, IL, USA). A two-tailed *P* value of less than 0.05 was considered statistically significant.

RESULTS

Patient baseline data were shown in Table 1. A total of 163 ICU patients underwent endotracheal intubation during the study period. According to the different laryngoscopy devices, 81 patients were assigned to the VL group and 82 patients to the DL group (Figure 1). The average age of the included patients was 69.29±16.22 years. The majority of patients was male, and estimated to be less than 100 kg. The most common indication for intubation was acute respiratory failure. Baseline features were evenly balanced between the two groups.

Endotracheal intubation characteristics of the included patients were shown in Table 2. The rate of successful first-pass intubation was not significantly different between the VL group and the DL group (67.9% vs. 69.5%, P=0.824). Moreover, the overall intubation success and total number of attempts to achieve intubation success did not differ between the two groups. In patients with successful first-pass intubation, the median duration of the intubation procedure did not significantly differ between the VL group (3.5 minutes) and the DL group (3 minutes) (P=0.923). The Cormack-Lehane grades of 1 or 2 (better glottis visualization) and the percentage of glottic opening score were similar, and no significant differences were found between the two groups. There were no statistical differences between the VL group and the DL group in intubation complications such as death, cardiac arrest, hypotension, hypoxemia,

Table 1. Patient baseline data

Characteristics	VL (*n*=81)	DL (*n*=82)	*P* value
Age, years, mean±SD	68.72±16.88	69.86±15.55	0.422
Male sex, *n* (%)	58 (71.6)	56 (68.3)	0.645
Estimated weight, *n* (%)			
< 76 kg	36 (44.4)	41 (50.0)	0.477
76–100 kg	33 (40.7)	32 (39.0)	0.823
101–150 kg	10 (12.3)	8 (9.8)	0.598
>150 kg	2 (2.5)	1 (1.2)	0.991
Reason for intubation, *n* (%)			
Acute respiratory failure	42 (51.9)	45 (54.9)	0.699
Acute circulation failure	13 (16.0)	15 (18.3)	0.704
Acute neurological failure	8 (9.9)	6 (7.3)	0.560
Trauma	12 (14.8)	9 (11.0)	0.464
Others	6 (7.4)	7 (8.5)	0.790

VL: video laryngoscopy; DL: direct laryngoscopy.

Table 2. Intubation characteristics

Characteristics	VL (*n*=81)	DL (*n*=82)	*P* value
First-pass success, *n* (%)	55 (67.9)	57 (69.5)	0.824
Overall success, *n* (%)	75 (92.6)	74 (90.2)	0.593
Number of intubation attempts, median (IQR)	1 (1–3)	1 (1–3)	0.886
Duration of intubation, minutes, median (IQR)	3.5 (2–5)	3 (2–4)	0.923
Difficult intubation, *n* (%)	7 (8.6)	8 (9.8)	0.806
Cormack-Lehane grade, *n* (%)			
1	42 (51.9)	36 (43.9)	
2	24 (29.6)	30 (36.6)	0.310
3	9 (11.1)	8 (9.8)	
4	6 (7.4)	8 (9.8)	
Percentage of glottic opening score, median (IQR)	82.5 (50–100)	85 (67.5–100)	0.535
Type of complication, *n* (%)			
Death	1 (1.2)	0 (0.0)	0.995
Cardiac arrest	1 (1.2)	0 (0.0)	0.995
Hypotension	16 (19.8)	19 (23.2)	0.595
Hypoxemia	14 (17.3)	12 (14.6)	0.644
Severe hypoxemia	4 (4.9)	2 (2.4)	0.666
Esophageal intubation	3 (3.7)	6 (7.3)	0.505
Aspiration	4 (4.9)	4 (4.9)	0.730
Arrhythmia	2 (2.5)	3 (3.7)	0.989
Dental injury	1 (1.2)	2 (2.4)	0.991

VL: video laryngoscopy; DL: direct laryngoscopy.

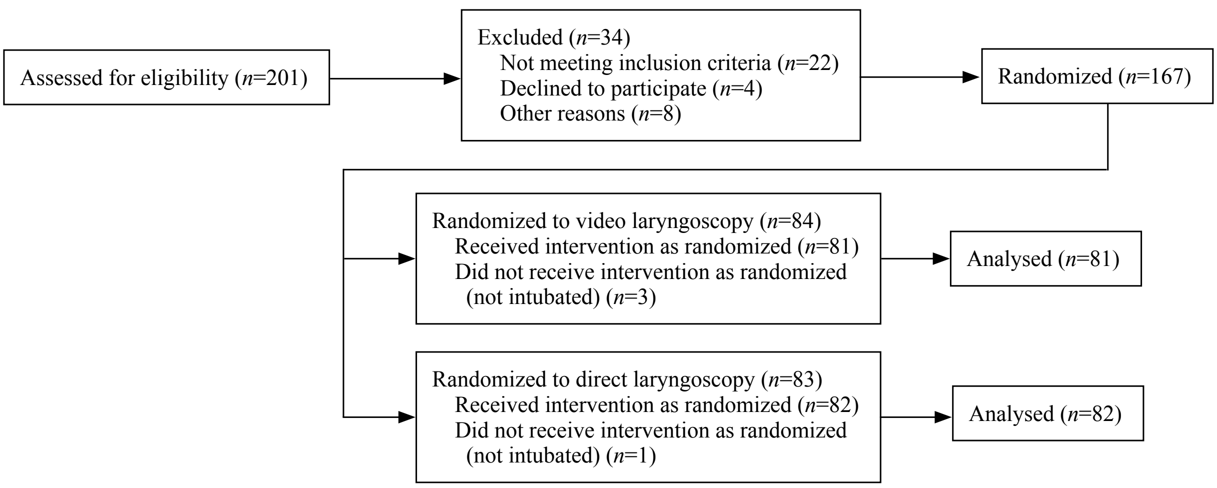

Figure 1. Flow of patients through the video laryngoscopy versus direct laryngoscopy for endotracheal intubation in ICU patients.

esophageal intubation, aspiration, arrhythmia, and dental injury.

DISCUSSION

The VL is a recently developed device that provides indirect visualization of the glottis via a camera, which has either a curved blade similar to the Macintosh laryngoscope or a tube channe.[13] VL has been extensively studied for intubation in the operating room and may facilitate endotracheal intubation compared with DL.[14] In the ICU, previous observational studies supported the use of VL for endotracheal intubation,[15] regardless of the predicted difficulty of intubation. Some of these studies also recorded adverse effects such as longer duration of the intubation procedure and higher mortality.[16,17] A recent systematic review found that VL may help to decrease intubation failure but did not improve the first attempt success.[18] Therefore, whether use of VL in ICUs is of greater benefit to patients deserves investigation. This study was designed to test the hypothesis that routine use of the VL for endotracheal intubation of patients in the ICU increased the rate of successful first-pass intubation compared with use of the DL. Meanwhile, this study added an objective primary outcome measure (capnography) to ensure a low risk of bias and high external validity.

Some previous studies had indicated that VL could improve the first-pass endotracheal intubation success rate compared with DL.[19,20] However, other studies failed to show improvements in VL compared with DL.[21,22] In a recent randomized clinical trial of 371 adults, the author found VL failed to improve first-pass endotracheal intubation rates and was associated with higher rates of severe life-threatening complications.[23] The present study suggested that VL did not improve the rate of successful intubation on the first attempt compared with DL.

Several factors may explain the discrepancy in results of early studies vs. recent RCTs, one of which was a high success rate in the DL group, related in particular to adherence to a standardized protocol, including routine sedation agents.[23] In addition, improved glottis visualization with VL was not translated into a higher success rate of first-pass intubation because tracheal catheterization under indirect vision was more difficult.[24] Conceivably, a VL with an intubation channel might improve the success rate, although preliminary data obtained in the operating room were inconclusive,[23] which requires further studies to assess the comparative effectiveness.

The present study found the frequency of intubation complications was similar between the VL and the DL group, which was incomplete consistent with the results reported previously. The better visualization of the glottis with VL might lead to a false impression of safety when intubation is performed. In addition, poorer alignment of the pharyngeal axis, laryngeal axis, and mouth opening despite good glottis visualization by VL could lead to mechanical upper airway obstruction and faster progression to hypoxemia.[24]

Endotracheal intubation performed by the anesthesiologist in the operating room has a low complication rate, because the patients are prescreened for difficult airway problems and have stable physiology, and the practitioner who experiences unanticipated difficulties often has the back out and wake-up option.[2] Furthermore, anesthesiologists have excellent manual skills in intubation, and have the advantage of extensive procedure practice. Endotracheal intubation in the ICU patients presents a different set of challenges. The patient may have an unrecognized difficult airway, minimal physiological reserve due to cardiopulmonary failure, and there is no back out or wake-up option. The rate of difficult intubation did not differ between the two groups in this study.[18] The difficult airway characteristics included bleeding, emesis, obstruction, restricted mouth opening, and obesity, etc.[25] The main reason for patients to experience first-pass intubation failure was because the glottis was not visualized during DL. For patients in the VL group, first-pass intubation failure was due to failure of tracheal catheterization. Therefore, the clinical application should take the concrete patients' conditions and environment into consideration.

VL has been shown to improve the physicians' view of the glottic opening, while this study failed to detect differences between the VL and the DL group. The present study examined both the Cormack-Lehane and percentage of glottic opening scores as both have previously been studied. Although these scores are commonly used, there are other tools that may help to better discriminate the challenges physicians encounter during intubation such as the intubation difficulty scale,[26] which incorporates multiple aspects including the number of attempts, number of operators, alternative devices if used, Cormack-Lehane grade, amount of force required, position of the vocal cords, and external laryngeal pressure if applied.

This study also presents several limitations. First, this was a randomized study, but not a multicenter trial, and with a limited amount and quality of data. Second, physician intubation expertise requires theoretical skills, manikin practice, and supervised hands-on training, which cannot be precisely defined individually. Third, it assessed a single type of video laryngoscope in the present study, which has a curved blade similar to the direct laryngoscope. Other video laryngoscopes with a hyperangulated blade or specific intubation channel might produce different results.

CONCLUSIONS

Among patients in the ICU requiring intubation, VL, compared with DL, did not improve the rate of successful first-pass endotracheal intubation. Further studies in multicenter, larger patient populations are desirable to assess the comparative effectiveness of these two strategies in different clinical settings and among operators with diverse skill levels.

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