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Original Article

A comparison of the video laryngoscope to the direct laryngoscope for endotracheal intubation in emergency department patients

Yongbo Sun, Shiming Zhang, Bin Lin

Department of Emergency, Medical Community of People's Hospital of Fenghua District, Ningbo, Zhejiang Province, China

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Abstract: Objective: To compare the video laryngoscope to the direct laryngoscope for tracheal intubation in emergency department patients. Methods: In total, 176 patients with respiratory failure, who were admitted for endotracheal intubation, were recruited in this prospective study. Patients in the experimental group received video laryngoscope for endotracheal intubation, while patients in the control group were treated with direct laryngoscope for endotracheal intubation (88 patients in each group). The one-time success rate, the insertion time, the success rate of cardiopulmonary resuscitation, and the degree of glottal exposure during endotracheal intubation in the two groups were compared. The heart rate, respiration, blood oxygen saturation, and systolic blood pressure in both groups at four time points, which were composed of before endotracheal intubation (T0), immediately after endotracheal intubation (T1), 30 min after endotracheal intubation (T2), and 1 h after endotracheal intubation (T3), were also compared. What's more, postoperative complications were compared between the two groups. Results: The insertion time in the experimental group was significantly shorter than that in the control group ($P<0.05$). The one-time success rate and effective glottal exposure rate in the experimental group were significantly increased when compared with the control group ($P<0.05$ and $P<0.01$, respectively). The heart rate, respiration, and systolic blood pressure at T1, T2, and T3 in the two groups after treatment were significantly lower than those before treatment, while blood oxygen saturation was significantly higher (all $P<0.05$). Compared with the control group, the systolic blood pressure at T1 in the experimental group was significantly declined ($P<0.05$). The total incidence of complications in the experimental group was significantly lower than that in the control group (6.82% vs. 18.18%, $P<0.05$). Conclusion: In emergency department, the application of video laryngoscope in patients with respiratory failure helps to shorten the intubation time, increase the one-time success rate, reduce the impact on hemodynamics, and decline the incidence of postoperative complications. It is worthy of clinical application.

Keywords: Video laryngoscope, endotracheal intubation, emergency department, respiratory failure, application value

Introduction

Endotracheal intubation refers to a process in which a catheter is inserted into trachea through the glottis of patients. It has a positive effect on maintaining vital signs and reducing mortality rate. And it has been the fastest, most effective, and most widely used technique for the treatment of critically ill patients [1, 2]. In the emergency department, endotracheal intubation is commonly used for the treatment of respiratory failure, which may be induced by various reasons. Patients with respiratory failure have abnormal respiratory function. And hypoxemia and dyspnea are the clinical manifestations [3-5]. In order to cure respiratory disorders, an artificial airway is supposed to be established in a timely and effective manner.

Endotracheal intubation is the fastest and most effective method to develop an artificial airway [6]. The application of laryngoscope in endotracheal intubation can be traced back to the 1990s. In the long-term clinical practice, it has been found that the exposure of glottal area is often incomplete when using direct laryngoscope for endotracheal intubation. Complica-

tions such as injury to the throat and dislocation of the arytenoid cartilage are often observed during the process of blind intubation of the blind area of visual field in and under epiglottis. Also, the intubation time and failure rate are increased [7]. In recent years, visualization technology has been quickly developed and been implemented in laryngoscopy. With visualization technology, external video is obtained. The damage on throat during intubation is thus effectively prevented. Doctors performed endotracheal intubation for 300 times were enrolled in a comparative study to perform direct laryngoscopy and video laryngoscopy for endotracheal intubation, respectively. In the study, results showed that operating time in the video laryngoscope group was significantly shorter than that in the direct laryngoscope group; the incidence of postoperative complications in the video laryngoscope group was significantly lower than that in the direct laryngoscope group [8]. However, for beginners, the intubation time was lengthened as a result of the difficulties in operating video laryngoscope. Therefore, Russell et al. reported that there was no significant difference between video laryngoscope and direct laryngoscope [9]. There is no medical evidence showing that the effect of video laryngoscope for endotracheal intubation is better than that of direct laryngoscope. Moreover, in the guidance, video laryngoscope is only recommended to perform endotracheal intubation after failing to complete using direct laryngoscope, rather than being the standard technique [10]. In a word, there is still no consistent conclusion. In this study, we compared video laryngoscope to direct laryngoscope for endotracheal intubation in patients with respiratory failure in the emergency department, hoping to provide more clinical evidence for the selection of laryngoscope.

Materials and methods

General information

This prospective study was conducted in 176 patients with respiratory failure, who were admitted to the emergency department of Medical Community of People's Hospital of Fenghua District for endotracheal intubation between June 2017 and June 2019. Patients were 21-78 years old, with an average age of 49.4±8.6 years old. According to the random number table, these patients were assigned to the experimental group (n=88) and the control group (n=88). In the experimental group, video laryngoscope was applied for endotracheal intubation, while direct laryngoscope was used in the control group for endotracheal intubation. The average age of patients in the experimental group and the control group were 49.8±9.7 and 49.3±7.8 years old, separately. All patients were followed up for 1 year after operation. This study was approved by the Ethics Committee of Medical Community of People's Hospital of Fenghua District. Informed consent was signed by the patients or their family members.

Inclusion and exclusion criteria

Inclusion criteria: All patients met the diagnostic criterion of respiratory failure defined in the 8th Edition of *Internal Medicine* [11]; patients aged over 18 years old; patients met the indications for establishing artificial airway; patients had complete clinical data.

Exclusion criteria: Patients with severe heart, liver, or kidney diseases; patients had tuberculosis or lung tumors; patients received endotracheal intubation previously; patients with difficulty or inconvenience in performing follow-up; patients had mental illness and could not cooperate with the researchers.

Methods

After admission, all patients with respiratory failure received routine rescue measures to improve the breath. Electrocardiogram (ECG) was used to detect patients' heart rate, respiration, blood oxygen saturation, mean arterial pressure, and so on. In the control group, foreign bodies existing in patients' respiratory tract were removed and direct laryngoscope was directly intubated to construct an artificial airway: with the body in a supine position, patients' head was tilted back; tongue was pushed away by the left-handed laryngoscope to make epiglottis exposed to laryngoscope; glottis was then exposed through provoking epiglottis; the prepared tracheal tube was inserted from glottis; patients' chest was lightly pressed when the tube was inserted into a suitable depth, and it reached trachea if there was airflow sound; after inserting the dental pad into mouth, laryngoscope was pulled out;

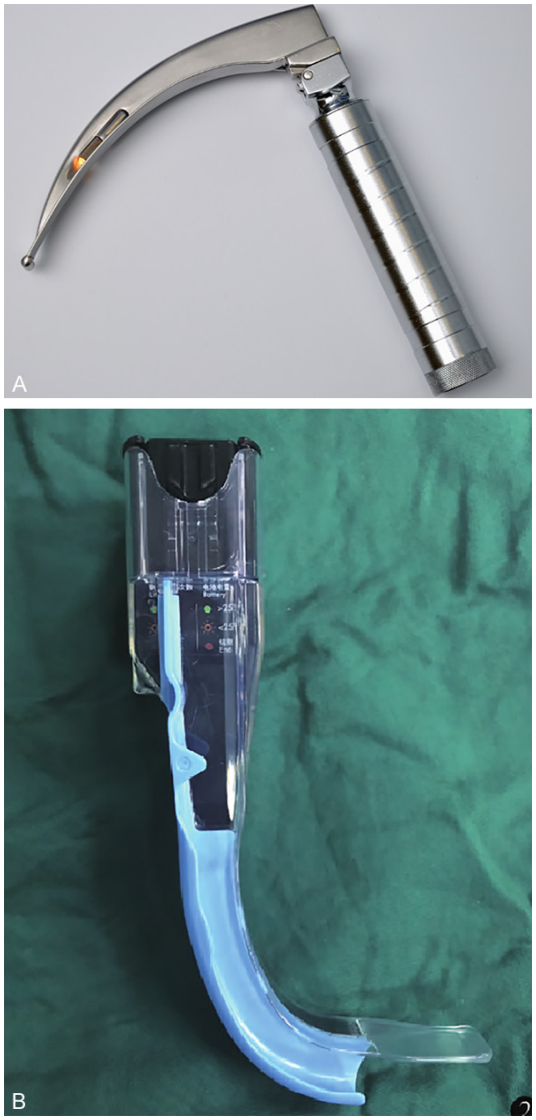

Figure 1. The image of direct laryngoscope and video laryngoscope. A: Direct laryngoscope; B: Video laryngoscope.

a stethoscope was used to detect the breath, and trachea was fixed when the breathing in both lungs was symmetric; a ventilator was externally connected for invasive mechanical ventilation. In the experimental group, video laryngoscope was used to complete endotracheal intubation. The whole process was the same as that in the control group. The images of direct laryngoscope and video laryngoscope were shown in **Figure 1**.

Outcome measures

Main outcome measures: The insertion time: The time from laryngoscope entered oral cavity to endotracheal intubation was fixed and recorded.

The one-time success rate: It meant that patients only received endotracheal intubation once. The one-time success rate = cases of endotracheal intubation at one time/the total number of cases * 100%.

The success rate of cardiopulmonary resuscitation: It referred to the incidence of successful cardiopulmonary resuscitation after endotracheal intubation. The success rate of cardiopulmonary resuscitation = cases of successful cardiopulmonary resuscitation after endotracheal intubation/the total number of cases * 100%.

The exposure of glottal area during operation using two types of laryngoscopes were recorded and allocated to grades I-IV, according to Cormack grading standard. Grade I: fully exposed glottis; Grade II: partially exposed glottis and visible posterior union; Grade III: the top of epiglottis was still visible, while glottis disappeared; Grade IV: epiglottis could not be exposed. The effective glottal exposure rate = (cases of Grade I + cases of Grade II)/the total number of cases * 100% [12].

Patients' heart rate, respiration, blood oxygen saturation, and systolic blood pressure at four time points, which consisted of before endotracheal intubation (T0), immediately after endotracheal intubation (T1), 30 min after endotracheal intubation (T2), and 1 h after endotracheal intubation (T3), were recorded [13].

Secondary outcome measures: Comparison of complications: The intraoperative and postoperative incidences of coughing, oral or gum bleeding, tooth loss or loosening, vomiting, restlessness, and so on, were recorded. The incidence of complications = cases of complications/the total number of cases * 100%.

Statistical methods

The whole data were analyzed using SPSS statistical software version 22.0. The normally distributed measurement data were calculated as mean ± standard deviation ($\bar{x}$ ± sd); independent sample t test was used for intergroup comparison, while paired t-test was applied for before-after comparison within the same group. The enumeration data were ex-

Table 1. Baseline data

Group	Experimental group (n=88)	Control group (n=88)	χ^2/t	P
Age (years)	49.8±9.7	49.3±7.8	0.377	0.707
Gender (male/female)	34/54	39/49	0.585	0.444
Types of respiratory failure			0.282	0.595
Type I	42	44		
Type II	46	44		
Causes of respiratory failure			0.334	0.987
Chronic obstructive pulmonary disease	40	42		
Severe asthma	4	5		
Severe pneumonia	30	29		
Pulmonary Edema	8	7		
Pulmonary interstitial fibrosis	6	5		
Time from onset to admission (min)	36.89±5.69	37.25±5.98	0.409	0.683
Body mass index (kg/m^2)	23.58±2.48	23.69±2.75	0.279	0.781
Comorbidity				
Hypertension	64	61	0.248	0.618
Type 2 diabetes	46	43	0.205	0.651
Hyperlipidemia	71	73	0.153	0.696
Obesity	26	30	0.419	0.517

Table 2. One-time success rate, insertion time, and success rate of cardiopulmonary resuscitation (n, %)

Group	Experimental group (n=88)	Control group (n=88)	χ^2/t	P
The one-time success rate (%)	82 (93.18)	69 (78.41)	7.879	0.005
The insertion time (s)	46.33±10.34	63.67±28.92	5.296	<0.001
The success rate of cardiopulmonary resuscitation (%)	74 (84.09)	72 (81.82)	0.161	0.688

pressed as number/percentage (n/%); comparison was conducted with Pearson chi-square test. The difference was statistically significant when *P* value was less than 0.05.

Results

Baseline data

There were no significant differences concerning age, gender, types of respiratory failure, causes of respiratory failure, time from onset to admission, body mass index, and comorbidity between the two groups (all P>0.05, **Table 1**).

The one-time success rate, insertion time, and success rate of cardiopulmonary resuscitation

As shown in **Table 2**, the one-time success rate in the experimental group was significantly higher than that in the control group (P< 0.01); compared with the control group, the insertion time in the experimental group was significantly reduced (P<0.01); there was no significant difference on the success rate of cardiopulmonary resuscitation between the two groups (P>0.05).

The degree of glottal exposure

The effective glottal exposure rate in the experimental group was significantly higher than that in the control group (P<0.01, **Table 3**).

Heart rate, respiration, systolic blood pressure, and blood oxygen saturation

As displayed in **Table 4**, heart rate, respiration, and systolic blood pressure at T0, T1, T2, and T3 in the two groups showed a downward trend, while blood oxygen saturation displayed an upward trend (all P<0.05); there were no significant differences on heart rate, respiration, and blood oxygen saturation at T0-T3 between the two groups (all P>0.05); systolic

Table 3. The degree of glottal exposure (n, %)

Group	Grade I	Grade II	Grade III	Grade IV	The effective glottal exposure rate (%)
Experimental group (n=88)	62 (70.45)	19 (21.59)	5 (5.68)	2 (2.27)	81 (92.05)
Control group (n=88)	38 (43.18)	30 (34.09)	17 (19.32)	3 (3.41)	68 (77.27)
χ^2	14.975				7.393
P	0.002				0.007

Table 4. Heart rate, respiration, systolic blood pressure, and blood oxygen saturation

Group	Experimental group (n=88)	Control group (n=88)	F	P
Heart rate (times/min)				
T0	112.36±11.26	114.25±11.89	1.083	0.280
T1	100.39±10.28[a]	100.26±10.24[a]	0.084	0.933
T2	94.21±9.87[a,b]	95.26±9.97[a,b]	0.702	0.484
T3	87.35±8.74[a,b,c]	89.21±8.84[a,b,c]	1.404	0.162
Respiration (times/min)				
T0	29.41±3.45	28.78±3.65	1.177	0.241
T1	25.26±3.21[a]	25.42±3.38[a]	0.322	0.748
T2	23.21±2.41[a,b]	23.14±2.44[a,b]	0.192	0.848
T3	18.98±1.45[a,b,c]	19.01±1.64[a,b,c]	0.129	0.898
Blood oxygen saturation (%)				
T0	59.85±4.46	59.97±4.63	0.175	0.861
T1	75.39±4.68[a]	74.29±4.36[a]	1.163	0.108
T2	80.95±5.98[a,b]	80.26±6.03[a,b]	0.762	0.447
T3	85.85±7.45[a,b,c]	84.21±7.12[a,b,c]	1.493	0.137
Systolic blood pressure (mmHg)				
T0	178.09±20.56	179.32±20.78	0.395	0.694
T1	168.73±17.82[a]	174.87±18.43[a]	2.224	0.026
T2	164.92±16.92[a,b]	169.23±16.82[a,b]	1.695	0.095
T3	159.47±15.92[a,b,c]	160.23±17.23[a,b,c]	0.304	0.762

Note: Compared with T0, [a]P<0.05; compared with T1, [b]P<0.05; compared with T2, [c]P<0.05. T0: before endotracheal intubation; T1: immediately after endotracheal intubation; T2: 30 min after endotracheal intubation; T3: 1 h after endotracheal intubation.

blood pressure at T1 in the experimental group was significantly reduced when compared with the control group (P<0.05), while there were no differences at T0, T2, and T3 (all P>0.05).

Postoperative complications

As shown in **Table 5**, the total incidence of complications in the experimental group was significantly lower than that in the control group (P<0.05); the incidence of oral or gum bleeding in the experimental group was significantly declined when compared with the control group (P<0.05).

Discussion

Respiratory failure is the pulmonary disorder of breathe and ventilation induced by various factors. Hypoxia symptoms accompanied by carbon dioxide retention or not, are then induced due to the inability of lungs to exchange oxygen effectively. Respiratory failure can cause body dysfunction, with a series of clinical symptoms [14, 15]. What needs to be clarified is that respiratory failure is a state of body dysfunction caused by other diseases [16]. In the emergency department, respiratory failure is the most commonly observed disease. Emergency doctors are focused on rapidly and

Table 5. Postoperative complications (n, %)

Postoperative complications	Experimental group (n=88)	Control group (n=88)	χ^2	P
Cough	2 (2.27%)	4 (4.55%)	0.609	0.406
Oral or gum bleeding	0 (0.00%)	4 (4.55%)	4.093	0.023
Tooth loss or looseness	1 (1.14%)	3 (3.41%)	1.023	0.312
Vomiting	1 (1.14%)	2 (2.27%)	0.339	0.560
Restlessness	2 (2.27%)	3 (3.41%)	0.206	0.650
In total	6 (6.82%)	16 (18.18%)	5.195	0.023

effectively establishing of artificial airway to improve the lung function of patients [17]. Endotracheal intubation is the most effective way to construct an artificial airway [18]. With the development of technology, visualization technology has been applied in endotracheal intubation. It was reported that the average intubation time in the video laryngoscope group was significantly lower than that in the direct laryngoscope group (45.6±10.7 s vs. 62.5±29.7 s), and the incidence of postoperative complications in the video laryngoscope group was significantly reduced when compared with the direct laryngoscope group [8]. El-Tahan et al. also reported that the intubation time of video laryngoscope was significantly shorter than that of direct laryngoscope [19]. In our study, results denote that video laryngoscope can shorten the intubation time and increase the one-time success rate, which were consistent with the results of above studies.

The degree of glottal exposure during the process of using laryngoscope for endotracheal intubation is particularly critical for the insertion of catheter. Compared with direct laryngoscopes, video laryngoscope has a clearer field of vision. Also, the operation is completed with the assistance of video images [20]. For patients with narrow airway, glottis can be well exposed, displaying a prominent advantage over direct laryngoscope [21, 22]. In our study, the degree of glottal exposure in the experimental group was significantly higher than that in the control group, which was consistent with the above studies.

Nipun et al. reported that systolic blood pressure and heart rate in the video laryngoscope group at 1-2 minutes after endotracheal intubation were higher than those in the direct laryngoscope group [22]. Wei et al. reported that there was a significant difference on postoperative systolic blood pressure between the video laryngoscope group and the direct laryngoscopes group, while the difference on heart rate fluctuations was unobvious; in addition, video laryngoscope could reduce postoperative hemodynamic fluctuation [23]. However, it was also reported that there were no significant differences on heart rate and hemodynamic fluctuation between the video laryngoscope group and the direct laryngoscopes group [8]. In our study, there were no significant differences concerning heart rate, respiration, and blood oxygen saturation between the two groups. The instant systolic blood pressure in the experimental group after intubation was significantly declined when compared with the control group, denoting that video laryngoscope is beneficial in the reduction of hemodynamic fluctuation. In terms of postoperative complications, it was reported that the incidence of sore throat and hoarseness in the direct laryngoscopy group was significantly increased when compared with the video laryngoscopy group. It was related to the injury of airway and throat mucosal during endotracheal intubation [8]. However, it was also reported that there were no significant differences on postoperative complications and airway injury between the direct laryngoscope group and the video laryngoscope group [23]. In our study, the incidence of oral or gum bleeding and the total incidence of complications in the control group were significantly higher than those in the experimental group, suggesting that oral mucosa and airway are prone to be damaged when using direct laryngoscope for endotracheal intubation. It might be related to the degree of glottal exposure and the blind area below epiglottis.

However, this is a single-centered prospective study conducted in a small number of patients. A multi-centered study will be further performed in a large number of patients to verify the application value of video laryngoscope in emergency department patients.

In summary, the application of video laryngoscope in patients with respiratory failure in emergency department can shorten the intubation time and increase the one-time success rate. It has little impact on patients' hemodynamics, and the incidence of postoperative complications is low. These results indicate that video laryngoscope is worthy of clinical application.

Disclosure of conflict of interest

None.

Address correspondence to: Yongbo Sun, Department of Emergency, Medical Community of People's Hospital of Fenghua District, No. 36 Park Road, Jinping Street, Fenghua District, Ningbo 315500, Zhejiang Province, China. Tel: +86-0574-88587059; E-mail: sunyongbo36yb@163.com

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