Comparative Analysis of Hemodynamic Responses and Oropharyngeal Complications in Tracheal Intubation: Evaluating Conventional, Video, and Rigid Video Laryngoscopes Under General Anesthesia

Liyu Wang, Hui Li, Yanni Zhong, Sanchun Ye, Jingjing Deng, Ting Pan, Yuenong Zhang

Background: This study aimed to compare the hemodynamic changes and the occurrence of oropharyngeal complications among patients undergoing tracheal intubation with an ordinary laryngoscope, video laryngoscope, and rigid video laryngoscope under general anesthesia.

Material/Methods: Patients undergoing elective tracheal intubation under general anesthesia were prospectively enrolled as study subjects. Hemodynamic indicators such as diastolic blood pressure (DBP), systolic blood pressure (SBP), mean arterial pressure (MAP), and heart rate (HR), as well as the incidences of oropharyngeal complications, including dental injury, oral mucosal injury, hoarseness, sore throat, and dysphagia, were observed in the patients of 3 groups (group A: ordinary laryngoscope, group B: video laryngoscope, group C: rigid video laryngoscope). Observations were made after anesthesia induction (T₀), immediately after tracheal intubation (T₁), and at 5 min after intubation (T₂).

Results: The HR at T₁ in group A was significantly higher than in groups B and C (P<0.05). However, the difference in the number of tracheal intubations was statistically significant among the 3 groups (P<0.05); group C exhibited the highest first-time success rate of tracheal intubation (95%), whereas group A had the highest failure rate (5%). Significant differences were also noted in the incidences of oral mucosal injury and sore throat among the groups (P<0.05), with the highest incidence in group A and the lowest in group C.

Conclusions: Compared with the ordinary laryngoscope, tracheal intubation using a video or rigid video laryngoscope results in milder hemodynamic impacts and fewer intubation-related complications. The rigid video laryngoscope may be safer and more effective.

Keywords: Anesthesia • Laryngoscopes • Intubation

Abbreviations: DBP – diastolic blood pressure; SBP – systolic blood pressure; MAP – mean arterial pressure; HR – heart rate; ASA – American Society of Anesthesiologists; BMI – body mass index; PETCO₂ – pressure of end-tidal CO₂; SpO₂ – pulse oxygen saturation; BIS – bispectral index

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**Introduction**

Tracheal intubation is one of the fundamental techniques in general anesthesia. With the continuous updating of medical equipment, visualization technology is increasingly valued and recommended by anesthesiologists; it can provide a clear view of the glottis and improve the success rate of tracheal intubation and thus reduce the number of operations attempted and operation duration [1].

At present, the tools for video laryngoscopic intubation mainly include video laryngoscope and rigid video laryngoscope, and the advantages of the video laryngoscope and rigid video laryngoscope compared with the ordinary laryngoscope have been supported by multiple studies [2-5]. Video and rigid video laryngoscopes offer advantages over ordinary laryngoscopes, but no comparative studies have evaluated these 3 types of laryngoscopes against each other. The few studies that have compared video versus rigid video laryngoscopes have mostly focused on obese patients [6], limiting their generalizability.

Additionally, there is no clear consensus on which tool is better for tracheal intubation when comparing video and rigid video laryngoscopes. In this study, we expanded the patient population to more comprehensively assess the effects of video, rigid video, and ordinary laryngoscopes on hemodynamics and oropharyngeal complications in patients undergoing tracheal intubation under general anesthesia. Our study aimed to thoroughly assess the strengths and weaknesses of each type of laryngoscope, reduce patient complications, and provide a valuable reference for clinical practice.

**Material and Methods**

**General Information**

This was a prospective randomized controlled study conducted in the Third Affiliated Hospital of Sun Yat-sen University-Yuedong Hospital, Meizhou, Guangdong, China, which was approved by the Ethics Committee of this hospital and registered in the Chinese Clinical Trial Registry (registration No. ChiCTR2200058965, http://www.chictr.org.cn/index.aspx). A total of 240 patients undergoing elective tracheal intubation under general anesthesia in this hospital between August 2021 and February 2024 were selected as the study subjects (Figure 1). Written informed consent was obtained from each patient before the study began.

Inclusion criteria were: patients aged 15-80 years, with American Society of Anesthesiologists (ASA) physical status grade I-II and preoperative airway Mallampati grade I-II (after the patient sat with mouth open and tongue extended, the observed pharyngeal structures were divided into 4 grades as follows: grade I: the soft palate, pharyngopalatine arch, uvula, and hard palate could be seen; grade II: the soft palate, uvula, and hard palate could be seen; grade III: the soft and hard palates could be seen; grade IV: only the hard palate could be seen), who planned to undergo elective surgery under general anesthesia. Exclusion criteria were: (1) patients who did not agree to sign a written informed consent form; (2) those with cardiac, pulmonary, or renal inefficiencies; (3) those who were allergic to known anesthetics; (4) those who could not tolerate the surgical procedure. The randomized grouping was conducted using a list of random numbers generated by Microsoft Excel. The names of groups with allocation numbers were sealed in an envelope, which was kept by the study supervisor. The sealed envelope was opened, and the group to which the patient belonged was determined after the patient had signed an informed consent form. According to the type of laryngoscope used for tracheal intubation, the patients were divided into 3 groups, with 80 patients in each group: Group A (ordinary laryngoscope), group B (video laryngoscope), and group C (rigid video laryngoscope).

**Preoperative Preparation and Anesthesia Induction and Maintenance**

The tracheal intubations were performed by the same anesthesiologist, with identical preoperative preparations across all 3 groups. All patients refrained from food and drink for more than 8 h before the operation. Upon admission to the room, intravenous access was established, and non-invasive monitoring of blood pressure, heart rate, pulse oxygen saturation (SpO₂), and electrocardiography was initiated. Additionally, preparations were made for monitoring the pressure of end-tidal CO₂ (PETCO₂). Mask-assisted ventilation was performed before anesthesia induction in all 3 groups, followed by rapid-sequence induction using etomidate 0.4 mg/kg, sufentanil 4 μg/kg, and cisatracurium phenylsulfonate 0.3 μg/kg. The tracheal intubation was performed at 3 min after mask ventilation. The anesthesia was maintained by inhaling sevoflurane 1-3%, intravenous infusion of remifentanil 0.2 μg/kg/min, and cisatracurium benzenesulfonate 1.5 μg/kg/min. The depth of anesthesia was monitored according to the electroencephalogram bispectral index (BIS); sufentanil 0.1-0.2 μg/kg was added each time to maintain the BIS value at 40-60; the intravenous infusion of cisatracurium benzenesulfonate was discontinued at half an hour before the end of the operation. The sevoflurane inhalation anesthesia was discontinued 15 min before the end of the operation. Intravenous infusion of remifentanil was discontinued at the end of the operation.

**Intubation Method**

An ordinary laryngoscope was used in group A (Figure 2A, 2B). Patients slightly raised their heads to expose the throat. The
operator stood at the head of the patient, gently pulled open the patient’s mouth with the right hand, and slowly inserted the laryngoscope into the mouth along the midline of the tongue of the patient with the left hand, avoiding touching the teeth and the hard palate. The anesthesiologist observed the laryngeal structure through the laryngoscope, placed the front end of the laryngoscopic lens at the root of the epiglottis and picked up the epiglottis to expose the glottis, then kept the laryngoscope motionless with the left hand, and put the endotracheal tube into the trachea with the right hand or with the help of an assistant, and finally withdrew the laryngoscope to complete the operation. An ordinary video laryngoscope was used in group B (Figure 2C, 2D). The anesthesiologist stood at the head of the patient and inserted the video laryngoscope into the mouth along the midline of the tongue of the patient with the left hand, and then slowly inserted it forward until the epiglottis appeared on the monitor screen, inserted the catheter with a core needle into the trachea along one side of the laryngoscope to the appropriate depth under the supervision of the monitor, and then pulled out the core needle to complete the operation. A rigid video laryngoscope was used in group C (Figure 2E, 2F). This placement prevented the lens from extending beyond the tube and being obstructed by secretions. During intubation, the anesthesiologist stood at the head of the patient. The left thumb was inserted into the mouth to lift the lower jaw, while the right hand held the lens (with the endotracheal tube) and inserted it into the oral cavity from the right corner of the mouth, guiding it along the lateral pharyngeal wall. Once the lens reached 11-12 cm (above the level of the larynx), the anesthesiologist redirected the lens towards the middle of the neck, observing the screen to locate the glottic structure. The endotracheal tube could then be advanced through the glottis; alternatively, the rigid lens was held stationary with the right hand while the left hand or an assistant advanced the endotracheal tube into the trachea. After positioning the tube, the rigid lens was withdrawn to complete the procedure. This tracheal intubation technique was performed by a senior anesthesiologist proficient in using all 3 types of laryngoscopes.

Successful intubation was considered to have been achieved when a uniform and regular PetCO₂ waveform appeared on the ventilator, with PetCO₂ levels at 35-45 mmHg, SpO₂ above 95%, and the auscultation of both lungs confirmed that the position of the endotracheal tube was correct. In cases of gastric content reflux, timely aspiration was required. The tracheal intubation was unsuccessful when the operation time reached 60 s, or the SpO₂ was <95%. The second operation would be performed after the patient was administered sufficient oxygen, and only 3 operations were allowed; 3 unsuccessful operations were considered as failure of tracheal intubation, and other methods would be used to complete the

![Randomized trial flow diagram](image-url)
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tracheal intubation. The preparation of the laryngoscope and the duration of tracheal intubation were required to be completed within 15 min. All patients received mechanical ventilation after tracheal intubation.

Observation Indicators

General information such as age, sex, smoking history, body mass index (BMI), ASA grade, and Mallampati grade, as well as intraoperative sufentanil dosage and intubation time, were recorded in the 3 groups. Diastolic blood pressure (DBP), systolic blood pressure (SBP), mean arterial pressure (MAP), and HR in the 3 groups were recorded after anesthesia induction (T₀), immediately after tracheal intubation (T₁), and at 5 min after tracheal intubation (T₂). The tracheal intubation conditions and related complications in the 3 groups were meticulously recorded. Complications primarily included dental injury, oral mucosal injury, and hoarseness, as well as sore throat and dysphagia in the pharynx. After tracheal intubation, any loosening or loss of teeth and bleeding of the gums caused by intubation were considered dental injuries. The presence of blood on the laryngoscope or visible bleeding in the oral cavity or lip mucosa caused by intubation was considered an oral mucosal injury. Hoarseness, sore throat, and difficulty swallowing were assessed during follow-up on the second postoperative day by comparing the patient’s condition before and after surgery through questioning. These indicators were documented and tallied by first-line anesthesiologists under the supervision of the chief anesthesiologist.

Statistical Methods

SPSS21.0 software was used for data processing and analysis. The measurement data of normal distribution were expressed as mean±standard deviation (x±SD). The one-way analysis of variance (ANOVA) and independent samples t test were used for inter-group comparison of measurement data. The chi-square test was used for inter-group comparison of count data. P<0.05 indicated that the difference was statistically significant.

Results

Comparison of General Data, Sufentanil Dosage, and Tracheal Intubation Time Among 3 Groups

There were no statistically significant differences in the general data of patients such as age, sex, smoking history, BMI, ASA grade, and Mallampati grade among the 3 groups (all...
there were also no statistically significant differences in sufentanil dosage and intubation time among 3 groups (all \(P>0.05\)); the experimental data were comparable among the 3 groups (Table 1).

**Table 1.** General information and comparison of intubation and extubation time among 3 groups.

<table>
<thead>
<tr>
<th>Indicators</th>
<th>Group A (n=80)</th>
<th>Group B (n=80)</th>
<th>Group C (n=80)</th>
<th>F/Chi-square value</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (age)</td>
<td>48.8±14.4</td>
<td>50.6±14.6</td>
<td>51.8±12.4</td>
<td>0.963</td>
<td>0.383</td>
</tr>
<tr>
<td>Gender (Male/Female)</td>
<td>39/41</td>
<td>45/35</td>
<td>42/38</td>
<td>0.902</td>
<td>0.637</td>
</tr>
<tr>
<td>Smoking history (with/without)</td>
<td>68/12</td>
<td>68/12</td>
<td>62/18</td>
<td>2.078</td>
<td>0.354</td>
</tr>
<tr>
<td>BMI</td>
<td>22.9±3.4</td>
<td>22.9±2.6</td>
<td>23.2±3.1</td>
<td>0.218</td>
<td>0.804</td>
</tr>
<tr>
<td>ASA grade (I/II)</td>
<td>11/19</td>
<td>13/17</td>
<td>12/18</td>
<td>0.276</td>
<td>0.870</td>
</tr>
<tr>
<td>Mallampati grade (I/II/III)</td>
<td>58.3±14.8</td>
<td>57.4±16.8</td>
<td>60.3±13.5</td>
<td>0.485</td>
<td>0.629</td>
</tr>
<tr>
<td>Dosage of sufentanil (μg)</td>
<td>32.1±8.2</td>
<td>33.2±8.0</td>
<td>34.1±7.9</td>
<td>1.421</td>
<td>0.182</td>
</tr>
<tr>
<td>Intubation time (min)</td>
<td>175.0±73.3</td>
<td>167.3±59.1</td>
<td>187.7±68.6</td>
<td>1.863</td>
<td>0.158</td>
</tr>
</tbody>
</table>

A – Ordinary laryngoscope; B – Video laryngoscope; C – rigid video laryngoscope. Intubation time: The time from the tracheal tube insertion to its removal.

**Table 2.** Comparison of hemodynamic indicators in patients at different time points among the 3 groups.

<table>
<thead>
<tr>
<th>Indicators</th>
<th>Time point</th>
<th>Group A (n=80)</th>
<th>Group B (n=80)</th>
<th>Group C (n=80)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SBP (mmHg)</td>
<td>T0</td>
<td>128.8±18.9</td>
<td>130.2±18.0</td>
<td>131.2±18.5</td>
</tr>
<tr>
<td></td>
<td>T1</td>
<td>143.2±28.3</td>
<td>148.5±27.4</td>
<td>140.5±28.0</td>
</tr>
<tr>
<td></td>
<td>T2</td>
<td>116.1±15.9</td>
<td>116.4±17.4</td>
<td>116.6±16.1</td>
</tr>
<tr>
<td>DBP (mmHg)</td>
<td>T0</td>
<td>76.9±11.1</td>
<td>76.8±10.3</td>
<td>78.8±11.6</td>
</tr>
<tr>
<td></td>
<td>T1</td>
<td>88.9±16.3</td>
<td>85.8±18.0</td>
<td>86.4±17.2</td>
</tr>
<tr>
<td></td>
<td>T2</td>
<td>70.7±12.6</td>
<td>70.0±12.6</td>
<td>70.8±11.6</td>
</tr>
<tr>
<td>MAP (mmHg)</td>
<td>T0</td>
<td>94.0±13.1</td>
<td>95.2±14.5</td>
<td>96.5±14.1</td>
</tr>
<tr>
<td></td>
<td>T1</td>
<td>107.1±18.7</td>
<td>102.9±21.1</td>
<td>103.4±20.3</td>
</tr>
<tr>
<td></td>
<td>T2</td>
<td>84.9±14.6</td>
<td>84.9±14.6</td>
<td>85.7±13.2</td>
</tr>
<tr>
<td>HR (time/min)</td>
<td>T0</td>
<td>74.6±12.2</td>
<td>72.7±12.2</td>
<td>72.1±12.6</td>
</tr>
<tr>
<td></td>
<td>T1</td>
<td>94.0±17.1</td>
<td>87.5±16.4</td>
<td>86.8±20.1</td>
</tr>
<tr>
<td></td>
<td>T2</td>
<td>66.7±12.8</td>
<td>65.8±12.8</td>
<td>63.5±12.4</td>
</tr>
</tbody>
</table>

Compared with T\(_0\), \(a P<0.05\); Compared with T\(_1\), \(b P<0.05\); compared with group A, \(c P<0.05\); A – ordinary laryngoscope; B – video laryngoscope; C – rigid video laryngoscope.

\(P>0.05\); there were also no statistically significant differences in sufentanil dosage and intubation time among 3 groups (all \(P>0.05\)); the experimental data were comparable among the 3 groups (Table 1).

**Pairwise Comparison of Hemodynamic Indicators in Patients at Different Time Points Among the 3 Groups**

SBP, DBP, MAP, and HR initially increased and then decreased in all 3 groups. Specifically, SBP, DBP, MAP, and HR at T\(_0\) were significantly higher than those at T\(_1\) and T\(_2\), whereas these values at T\(_2\) were significantly lower than those at T\(_0\) and T\(_1\), with all differences being statistically significant (all \(P<0.05\)). Across the groups, HR at T\(_1\) in group A was significantly faster than in groups B and C, with both differences also being statistically significant (\(P<0.05\)). Comparisons of HR at T\(_1\) and T\(_2\), as well as SBP, DBP, and MAP from T\(_0\) to T\(_1\) in group A with those in groups B and C, showed no statistically significant differences (all \(P>0.05\)); the differences in these indicators at the 3 time points between groups B and C were not statistically significant (all \(P>0.05\)). See Table 2 for detailed data.
Table 3. Comparison of intubation condition in patients among 3 groups [n (%)].

<table>
<thead>
<tr>
<th>Group</th>
<th>1 intubation</th>
<th>2 intubations</th>
<th>3 intubations</th>
<th>Intubation failure</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>64 (80)</td>
<td>12 (15)</td>
<td>0 (0)</td>
<td>4 (5)</td>
</tr>
<tr>
<td>B</td>
<td>69 (86.25)</td>
<td>7 (8.75)</td>
<td>3 (3.75)</td>
<td>1 (1.25)</td>
</tr>
<tr>
<td>C</td>
<td>76 (95)</td>
<td>4 (5)</td>
<td>0 (0)</td>
<td>0 (0)</td>
</tr>
</tbody>
</table>

Comparing the three groups, the Chi-square value was 16.504, and the P-value was 0.011. 1 intubation: First attempt at intubation was successful; 2 intubations: Second attempt at intubation was successful; 3 intubations: Third attempt at intubation was successful; Intubation failure: None of the three intubation attempts were successful.

Table 4. Comparison of tracheal intubation complications among 3 groups of patients [n (%)].

<table>
<thead>
<tr>
<th>Group</th>
<th>Dental injury</th>
<th>Oral mucosal injury</th>
<th>Hoarseness</th>
<th>Sore throat</th>
<th>Dysphagia</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0 (0)</td>
<td>22 (27.5)</td>
<td>3 (3.75)</td>
<td>17 (21.25)</td>
<td>3 (3.75)</td>
</tr>
<tr>
<td>B</td>
<td>1 (1.25)</td>
<td>8 (10)*</td>
<td>0 (0)</td>
<td>7 (8.75)*</td>
<td>2 (2.5)</td>
</tr>
<tr>
<td>C</td>
<td>0 (0)</td>
<td>2 (2.5)*</td>
<td>2 (2.5)</td>
<td>4 (5)*</td>
<td>1 (1.25)</td>
</tr>
</tbody>
</table>

Chi-square value = – 22.788, P-value = <0.001, 0.239, 0.004, 0.599.

Compared with group A, *P<0.05.

Comparison of Intubation Condition in Patients Among the 3 Groups

There was a statistically significant difference in the distribution of the number of intubations among the 3 groups (P<0.05); the first-time success rate of tracheal intubation was the highest (95%) in group C; the failure rate of tracheal intubation was highest in group A, which was 5% (Table 3).

Comparison of the Incidence of Tracheal Intubation Complications in Patients Among the 3 Groups

There were no statistically significant differences in incidences of dental injury, hoarseness, and dysphagia in patients among the 3 groups (all P>0.05), whereas there were statistically significant differences in incidences of oral mucosal injury and sore throat among the 3 groups (all P<0.05), all of which were highest in group A and lowest in group C (Table 4).

Discussion

Video and rigid video laryngoscopes play an essential role in general anesthesia tracheal intubation, which is a strong physiological stimulus that can cause the excitation of the sympathetic nervous system of patients. This excitation increases the release of catecholamine hormones such as norepinephrine and epinephrine, which can cause vasoconstriction and accelerated heart rate, resulting in higher blood pressure and a faster heart rate in patients [7,8]. Lin Feng et al [6] used a rigid video laryngoscope for tracheal intubation, which had less hemodynamic impact and relatively fewer intubation-related complications in patients undergoing bariatric surgery than the ordinary video laryngoscope. However, that study included a relatively small number of cases (n=30) per group and many of their patients had a higher BMI. Consequently, the scope of that study was quite limited and may not fully represent the actual conditions of tracheal intubation in clinical anesthesia. In the present study, patients undergoing elective tracheal intubation under general anesthesia were prospectively selected. We observed hemodynamic indicators such as DBP, SBP, MAP, and HR, as well as the incidences of oropharyngeal complications – including dental injury, oral mucosal injury, hoarseness, sore throat, and dysphagia – across 3 groups (ordinary laryngoscope, video laryngoscope, rigid video laryngoscope) after anesthesia induction, immediately after intubation, and at 5 min after intubation. This study aimed to provide a reference basis for tracheal intubation in clinical anesthesia practice.

When performing tracheal intubation with an ordinary laryngoscope, it is necessary to align the patient’s oral, pharyngeal, and laryngeal axes as much as possible on the same horizontal plane, which gives the physician a better direct line of sight to the glottis or epiglottis. This process often requires the patient to hyperextend their head backward, and the physician must exert considerable force to lift the mandible, resulting in a significant stress response and potentially greater patient injury. In contrast, when using a video laryngoscope for...
tracheal intubation, aligning the oral, pharyngeal, and laryngeal axes on the same horizontal plane is not required, nor is hyperextension of the patient’s head or excessive force needed to lift the mandible. The image at the front end of the video laryngoscope can be displayed clearly on the screen through signal transmission, allowing for a clear view of the glottis or epiglottis. A curved endotracheal tube can then be directly inserted into the airway, thus reducing the stress response and its impact on heart rate and mean arterial pressure. Specific differences exist in the availability of ordinary laryngoscopes, video laryngoscopes, and rigid video laryngoscopes across institutions. Ordinary laryngoscopes are universally equipped, but the high cost of video laryngoscopes and rigid video laryngoscopes means some institutions have not purchased them. Consequently, there are variations in the quality of anesthesia, the incidence of patient complications, and the ability to manage difficult airways. Therefore, research is needed to guide clinical practice in proposing better solutions. Additionally, video laryngoscopes and rigid video laryngoscopes are excellent teaching tools, enabling students to quickly master tracheal intubation.

Compared with the ordinary laryngoscope, the video and rigid video laryngoscopes are equipped with monitors or cameras that display the image of the larynx on the screen so that the doctor can visually see the glottis and other laryngeal structures, shorten the intubation time, and thus significantly improve the accuracy and success rate of tracheal intubation [9], and this may also lead to less fluctuation in hemodynamics after tracheal intubation. This study revealed that although the blood pressure indicators such as SBP, DBP, and MAP in groups B and C did not show any significant difference from those in group A, the HR in groups B and C was significantly lower than that in group A, which further confirmed that the video laryngoscope and rigid video laryngoscope have an advantage relative to the ordinary laryngoscope in mitigating the stress response that causes fluctuation in hemodynamic indicators, which is in line with the findings of several relevant studies [10, 11]. The blood pressure and heart rate in patients of the 3 groups showed an increasing trend immediately after tracheal intubation. However, they slowly decreased and stabilized at the later stage, which was related to the intense airway stress response of tracheal intubation. It was difficult for the anesthetic drugs to completely inhibit the stress response immediately after tracheal intubation. However, the anesthetic drugs were sufficient to inhibit the airway stress response after completion of intubation. This may be an important reason why the hemodynamic indicators such as blood pressure and heart rate in the patients of the 3 groups in this study first increased and then decreased.

In the stress response, the levels of adrenaline and norepinephrine in the body increase rapidly. The activation of the sympathetic nervous system can cause an accelerated heart rate. It can also affect the blood vessels, thus leading to increased blood pressure. However, blood pressure regulation involves more than just the influence of the autonomic nervous system. In addition to the influence of the autonomic nervous system, it is also affected by various factors such as intravascular volume, vascular resistance, and cardiac function [12]. Therefore, changes in blood pressure may not be as rapid and pronounced as heart rate changes. Additionally, the non-invasive monitoring methods used in this study may not reflect changes in blood pressure as quickly as with invasive monitoring, and this delay might explain why only heart rate among the hemodynamic indicators showed a significant difference in this study. In each group, the dosage of cisatracurium was standardized according to the patient’s weight in kilograms. The muscle relaxation effect lasts 15-25 min after stopping the infusion. Our study protocol stopped the infusion 30 min before the end of surgery, so we believe that cisatracurium would not significantly impact heart rate.

In this study, the first-time success rate of tracheal intubation in group C was 95%, significantly higher than the 80% in group A and 86.25% in group B. This higher success rate may be attributed not only to the rigid video laryngoscope’s ability to expose the glottis – thus reducing the difficulty of tracheal intubation through its display device – but also to its unique design that conforms to the curvature of the oropharyngeal airway. This design allows the camera to be precisely aimed at the glottis once the laryngoscope is in position, enabling the image of the glottis to appear on the monitor. Consequently, the operator’s line of sight overcomes the obstruction of glottopharyngeal structures, allowing visibility of structures that cannot be seen under direct vision. However, in cases where there is a significant presence of secretions in the patient’s oral cavity, suctioning may be necessary to clear the field and facilitate the procedure.

During tracheal intubation, the insertion of the laryngoscope and endotracheal tube will directly contact the oral mucosa and throat, which can cause physical stimulation and injury to these parts due to friction or pressure, leading to obstruction of local blood circulation, tissue hypoxia, and insufficient supply of nutrients in these parts, which can lead to injury [13, 14]. At the same time, the local tissue injury caused by surgical operation stimulates the inflammatory response and release of inflammatory mediators such as histamine and prostaglandins, which can stimulate nociceptive nerve endings and cause pain [15]. In this study, the incidences of oral mucosal injury and sore throat were significantly lower in groups B and C than in group A. This improvement is likely due to the high-definition imaging provided by the video and rigid video laryngoscopes, which allow for more precise positioning. This capability makes insertion and manipulation easier and more
intuitive, enabling clinicians to more accurately control the position and depth of the laryngoscope. Consequently, this reduces the pressure on and injury to the oral mucosa and pharyngeal tissues.

Conclusions

In summary, compared to the ordinary laryngoscope, the video and rigid video laryngoscopes used for tracheal intubation under general anesthesia offer significant advantages in mitigating the stress response that leads to fluctuations in hemodynamic indicators and reducing postoperative oral mucosal injury and sore throat in patients. Furthermore, the rigid video laryngoscope demonstrates a high first-time success rate in tracheal intubation among general anesthesia patients. This highlights the rigid video laryngoscope as a valuable tool with significant potential for widespread adoption in modern anesthesia practice. However, this was a single-center study, and multi-center studies are essential for confirmation. Additionally, this study did not include patients younger than age 15 years, which is a limitation.

Declaration of Figures’ Authenticity

All figures submitted have been created by the authors, who confirm that the images are original with no duplication and have not been previously published in whole or in part.

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