The Correlation between Blood Pressure Elevation and Intubation Time during Tracheal Intubation using Lightwand or Direct Laryngoscope

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Background: The intensity of stimulation of intubation was expressed as the product of its force and duration. Theoretically, use of a lightwand might cause less adrenergic stimulation because the elevation of the epiglottis by the laryngoscope blade was not required. However, whether the hemodynamic responses to intubation with the lightwand differ from those with direct laryngoscope was a controversial topic. Additionally, there has been no clear study showing that the hemodynamic response to intubation is affected by intubation time. This study was designed to analyze the relationship between the magnitude of hemodynamic responses and the intubation time.

Methods: 50 ASA class 1, 2 elective surgical patients were randomly allocated into two groups; lightwand or direct laryngoscope group. Anesthesia was induced by a standardized technique. The changes in MAP and HR were recorded just before intubation, after intubation and 1 minute after intubation. Also the intubation time was recorded.

Results: There were no differences in MAP, HR, and intubation time between the groups. The following was the final regression equation from multiple linear regression analysis: the degrees of blood pressure elevation = + 11.2239 (P = 0.0296) + 6.6331 (P = 0.0846) × (group) + 1.0400 (P = 0.0004) × (intubation time). Adjusted R² is 0.84 (P < 0.05).

Conclusions: There was a linear relation between the degree of blood pressure elevation and intubation time in direct laryngoscope group and lightwand group. (Korean J Anesthesiol 2007; 52: S 9 ~ 13)

Key Words: endotracheal intubation, hemodynamic responses, laryngoscope, lightwand.

INTRODUCTION

Tracheal intubation commonly results in a sympathetic stimulation manifested by increased heart rate and arterial blood pressure. The intensity of the stimulation exerted during laryngoscope is expressed as the product of its average force (i.e. the force to tongue base by the tip of direct laryngoscope) and duration (i.e. the time required of stimulation). 1) Theoretically, use of the lightwand for tracheal intubation may cause less adrenergic stimulation, because elevation of the epiglottis by the laryngoscope blade is not required. However, whether the hemodynamic responses to intubation with the lightwand differ from those with direct laryngoscope is still a controversial topic. And also there have been no definite results about the influence of intubation time on the changes in blood pressure. This study was designed to determine the difference in hemodynamic responses to intubation between the lightwand and direct laryngoscope, and to examine the correlation between blood pressure elevation and intubation time.

MATERIALS AND METHODS

After obtaining approval from our institutional research committee and informed consent from each patient, we studied 50 healthy adult patients (ASA physical status I or II) aged over
18 years and under 60 years, undergoing elective surgery. Patients with hypertension, cardiovascular disease, or arteriosclerosis were excluded from the study. Also excluded were those with a previous history of a difficult tracheal intubation or those with expected difficulty in intubation on physical examination. Patients were randomly assigned to one of the following two groups: direct laryngoscope (Macintosh blade) intubation group (DL group; n = 25) and lightwand (Trachlight©; Laerdal Medical, Armonk, NY) intubation group (LW group; n = 25) (Table 1). An one anesthesiologist experienced in using the lightwand and laryngoscope performed all intubating procedures.

Thirty minutes before the induction of anesthesia, patients were premedicated with glycopyrrolate 0.2 mg IM. The anesthetic technique was standardized as follows: on arrival in the operating room, standard anesthetic monitoring devices were applied to the patients. Each patient was preoxygenized with 100% oxygen at a flow rate of 5 L/min for 5 min. Anesthesia was induced with intravenous administration of 1% propofol 2 mg/kg and vecuronium 0.1 mg/kg. The lungs were ventilated manually via a face mask with enflurane 2–2.5 vol% in oxygen 5 L/min.

After the optimal end-tidal enflurane concentration (approximately 2 vol%) was reached and the train-of-four count became zero, the trachea was intubated with either lightwand (LW group) or direct laryngoscope (DL group). A well-lubricated silicone straight tracheal tube which is 7.5-mm internal diameter for men or 7.0-mm for women, was used. In the DL group, tracheal intubation was done with a size 3 Macintosh laryngoscope without stylet in the sniffing position. In the LW group, tracheal intubation was done with a size 3 Macintosh laryngoscope without stylet in the sniffing position. In the LW group, the lightwand was introduced into the tracheal tube, and the proximal end of the tube was bent to a 90° angle. Jaw lift was applied. The room lights were dimmed during tracheal intubation with lightwand. Lighwand was advanced until midline illumination was observed in the anterior neck. Then the stylet was withdrawn and the tracheal tube was advanced until the glow disappeared behind the sternal notch.

Mean arterial pressure, heart rate, intubation time, end-tidal concentration of enflurane and intubation attempt frequency were recorded. Mean arterial pressure and heart rate were recorded at the following time points: a) before intubation; b) after intubation; c) one minute after intubation. We also recorded the intubation time, which was defined as the time required from the device’s insertion until its removal (DL group) and the time required from jaw lifting until the device’s removal (LW group).

Data are expressed as mean ± SD (standard deviation). Statistical analysis was performed with the SAS (version 8.1, SAS institute Inc, USA) software. For unpaired data Student’s t-test was used for comparison between groups. For the repeated measurements, analysis of variance was used. A multiple linear regression analysis was used to detect the significant factors involved in the elevation of blood pressure. Dependent variable was changes in the blood pressure, and intubation time, group, anesthetic concentration, intubation attempt frequency, age, body weight and height were put as independent variables. A stepwise selection method was used for selection of these variables. Statistical significance was declared if P < 0.05.

RESULTS

There were no significant differences between the groups with regard to demographic characteristics, anesthetic concentration at intubation, intubation attempt frequency, mean arterial pressure at any time during the study, or intubation time (Table 1, 2).

Intubation time was 9.01 ± 6.36 sec and 8.48 ± 6.13 sec in DL group and LW group, respectively. There was no significant differences in intubation times between two groups.

The final multiple linear regression equation is as follows:

\[ \text{Degrees of blood pressure elevation (\(\Delta BP\))} = + 11.2239 + 6.6331 \times \text{Group} + 1.0400 \times \text{Intubation time} \]

A level for entry into the model is P < 0.05. After Stepwise procedures for a dependent variable, the variables of constant (P = 0.0296), group (P = 0.0846), and intubation time (P = 0.0004) were selected, but other variables were removed. R

Table 1. Demographic Data

<table>
<thead>
<tr>
<th>Measurements/group</th>
<th>DL</th>
<th>LW</th>
</tr>
</thead>
<tbody>
<tr>
<td>SEX (M/F)</td>
<td>11/14</td>
<td>10/15</td>
</tr>
<tr>
<td>Age (yr)</td>
<td>41.9 ± 12.2</td>
<td>41.4 ± 11.7</td>
</tr>
<tr>
<td>Body weight (kg)</td>
<td>61.4 ± 9.5</td>
<td>59.4 ± 9.0</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>163.2 ± 9.2</td>
<td>162.7 ± 8.6</td>
</tr>
</tbody>
</table>

Age, body weight and height values are mean ± SD. DL: direct laryngoscope group, LW: lightwand group. There are no significant difference in various measurements between groups.
Table 2. Values of Measurements of Each Group

<table>
<thead>
<tr>
<th>Measurements/group</th>
<th>DL</th>
<th>LW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anesthetic concentration (vol%)</td>
<td>1.83 ± 0.25</td>
<td>2.04 ± 0.45</td>
</tr>
<tr>
<td>Intubation trial frequency</td>
<td>1.00 ± 0.00</td>
<td>1.20 ± 0.50</td>
</tr>
<tr>
<td>MAP before intubation (mmHg)</td>
<td>74.28 ± 9.78</td>
<td>75.60 ± 14.51</td>
</tr>
<tr>
<td>MAP after intubation (mmHg)</td>
<td>99.32 ± 17.29</td>
<td>106.48 ± 14.36</td>
</tr>
<tr>
<td>MAP after 1 min (mmHg)</td>
<td>96.64 ± 14.68</td>
<td>101.76 ± 12.30</td>
</tr>
<tr>
<td>Intubation time (sec)</td>
<td>9.01 ± 6.36</td>
<td>8.48 ± 6.13</td>
</tr>
</tbody>
</table>

Values are mean ± SD. DL: direct laryngoscope group, LW: Lightwand group, MAP: mean arterial pressure, Intubation time: the duration time from the device’s insertion until its removal (DL group) or the duration time from jaw lifting until the device’s removal (LW group). There are no significant difference in various measurements between groups.

DISCUSSION

Tracheal intubation is associated with transient increases in systemic blood pressure and heart rate due to sympathetic stimulation. According to Hassan et al., stimulation of proprioceptors at the base of the tongue during laryngoscope induces impulse-dependent increases in systemic blood pressure, heart rate and plasma catecholamine concentrations. The intensity of the stimulus exerted during laryngoscope is expressed by the product of its average force (i.e. the force to tongue base by the tip of direct laryngoscope) and duration (i.e. the time required of stimulation). There have been many attempts to minimize the hemodynamic response to laryngoscope and intubation, using various pharmacological therapies or alternative intubation techniques. The lightwand technique requires neither elevation of the epiglottis by the laryngoscope blade nor exposure of the glottic opening. Thus we predicted that the lightwand technique would cause less circulatory changes than standard direct laryngoscope. But, the result from this fragmentary prediction previously does not well correspond with the results of the different studies but also with our outcome. Therefore, there is still a controversy about the correlation between hemodynamic response and various intubation techniques.

Several groups have investigated the possibility that lightwand intubation may result in less stimulation than direct laryngoscopy and may protect from sympathetic hyperactivity. Oh et al. reported more stable hemodynamic response in lightwand group in the comparison study of two tracheal intubation technique in adult 40 women. They assumed that less hemodynamic response in lightwand group attributed to shorter intubation time, and also assumed another factors which could affect the result, but they could not demonstrate that in the concrete because of small subject number and possibility of bluntness of other factors by inhalational anesthetics. Nishikawa
et al also reported that the lightwand technique was accompanied by smaller increases of blood pressure than the laryngoscope in 40 normotensive patients even though the lightwand technique needed significantly more frequent attempts and a longer intubation time than the laryngoscope technique. However, in another 40 hypertensive patients there were no difference in hemodynamic changes between the two techniques. In their study, 2\(\mu\)g/kg of fentanyl was administered before intubation, which could attenuated hemodynamic responses to tracheal intubation.

In contrast, Oh et al described that there was no difference between two intubation technique. The intubation time in lightwand group was 14.5 seconds (mean value), which was not different statistically to 16.8 seconds (mean value) in direct laryngoscope group, and also they assumed that direct tracheal stimulation of tube would be a major factor to hemodynamic response in tracheal intubation, which was also reported by Takahashi et al. As well, Hirabayashi et al found that the circulatory responses to tracheal intubation were similar between the two techniques. In the lightwand intubation technique, the jaw is grasped and lifted upward using the thumb and index finger of the intubator’s hand. They assumed that this maneuver seems to be gentle compared with direct laryngoscope, but it was sufficient to cause circulatory responses. There was the same result in the study of old patients with hypertension by Kanaide et al, like the study of Hirabayashi et al jaw-lift technique for tracheal intubation with a lightwand device could cause perilyrungal stimulation, a major factor of hemodynamic response. Simultaneously they also reported that direct tracheal stimulation of tube would be a major factor to hemodynamic response in tracheal intubation. Montes et al studied 80 patients undergoing elective coronary artery bypass grafting, they reported that using a lightwand intubation technique does not modify the hemodynamic response associated with endotracheal intubation as compared with standard direct laryngoscopy. Using fentanyl 5\(\mu\)g/kg for anesthesia induction drug attenuated the hemodynamic response.

On the other hand, there are various reports about intubation time. Oh et al reported that the intubation time in lightwand group was 3.9 ± 0.6 sec, which was shorter than 4.3 ± 0.5 sec in direct laryngoscope group, and so shorter intubation time attributed to less hemodynamic response, while Kanaide et al demonstrated that even though the intubation time for the lightwand group (12.6 ± 1.7 sec) was shorter than the direct laryngoscope group (23.5 ± 2.9 sec), but there was no significant difference in hemodynamic responses between the two groups, which was also reported by Hung et al. Knight et al reported that the duration of laryngoscopy was an important variable associated with the magnitude of the increase in heart rate and mean arterial pressure, i.e. doubling the duration of laryngoscopy was associated with a near doubling of the percent increase in mean arterial blood pressure and heart rate during laryngoscopy.

In our study, the intubation time was 8.48 ± 6.13 sec (LW group) and 9.01 ± 6.36 sec (DL group) with no significant difference. And we found that the circulatory responses to lightwand intubation were similar to those of direct laryngoscope. We excluded patients with hypertension and old aged person out of study subject, who could excessively respond to tracheal stimulation. And we did not give opioid which could blunt hemodynamic respond to tracheal intubation. Also, there was no difference in end-tidal concentration of inhalational anesthetics at intubation. And only one well-trained anesthesiologist was involved in tracheal intubation procedure. Therefore, we can analyze that no difference of hemodynamic response between each intubation technique was attributed to the similar intubation time between groups.

We designed a statistical model that could explain a change in blood pressure elevation after tracheal intubation, which can be represented by regression of the intensity of stimulation and the duration time of stimulation. The functional equation is as follows:

\[
\text{Blood pressure elevation} = f(\text{intensity of stimulation}) \times \text{duration time of stimulation}
\]

Thus our regression equation is:

\[
\text{Degree of blood pressure elevation} = \text{intercept} + m \times \text{group} + n \times \text{time}
\]

Where \(m\) and \(n\) are partial regression coefficients. We would regard the sum of intercept term and \(m \times \text{Group term}\) as a new intercept. We presumed that the difference in the slope \(m\) between the groups is the difference in intensity of stimulation following each intubation technique. From our result, the difference in the slope \(m\) between both groups was statistically insignificant at the 95% confidence interval. From the above equation, if the term of the new intercept replaces a constant number term, the final regression equation is as follows:
Degrees of blood pressure elevation = intercept + n × time

If we have applied our result to the Hassan’s equation (i.e. Blood pressure elevation = intensity of stimulation × duration of stimulation), there are no difference of blood pressure elevation and intubation time between both groups, finally we can find that there are no difference in the intensity of stimulation between LW group and DL group. In other words, if there are no difference in the stimulation intensity, then the degree of blood pressure elevation would have a linear relation to the intubation time.

Knight et al 10 reported that if there were no differences in intensity of stimulation, laryngoscope manipulation time would be the most important factor affecting hemodynamic response. Therefore, we concluded that it was more important to shorten the intubation time for minimizing the hemodynamic response to tracheal intubation rather than what intubation technique will be used.

According to previous studies, where the difference in time was not controlled strictly, investigators were generally confused when they analyzed results by the difference of time. But by using regression for the difference of blood pressure elevation by a function of time, we could mathematically separate the effect of intensity of stimulation, which is remarkable when compared to other studies. In clinical situation, the intubation time of direct laryngoscope could be different to that of lightwand, and probably it would be impossible to identify the each intubation time. Therefore, we should keep in mind that the degree of blood pressure elevation could actually be different even if the intensity of stimulation during intubation is the same whether using direct laryngoscope or the lightwand.

In conclusion, there is a linear relation between the degrees of blood pressure elevation and the intubation time in the direct laryngoscopic group and the lightwand group; thus there wasn’t any difference among groups when the intubation time was replaced with the intensity of stimulation.

### REFERENCES