Comparative Evaluation of Tube First Versus Video Laryngoscope First Techniques in a Normal and Simulated Difficult Airway Model: A Randomized Controlled Trial

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In patients with difficult airways, there can be difficulty with advancing the endotracheal tube into the airway even with a good view of the glottis using video laryngoscopy. The purpose of this study was to determine if the time required to intubate an airway and the number of gaze changes by the laryngoscopist could be decreased by using a novel video laryngoscope technique. Sixteen experienced Certified Registered Nurse Anesthetists were recruited to intubate a manikin with a normal or difficult airway using both the laryngoscope first technique and a new endotracheal tube first technique (4 intubations total) in a randomized sequence. The data were analyzed with the Mann-Whitney (U) test to compare the differences between the normal and difficult airway conditions. Although no significant difference was noted in the time to intubation between intubation techniques, the number of gaze changes was found to be significantly fewer in the tube first technique \((P=.0009)\). A steep learning curve, associated with the accommodation of the manikin, was demonstrated by a decrease in time and gaze changes with subsequent intubations. Incorporating the endotracheal tube first technique into an education curriculum could increase patient safety by decreasing the time to secure a difficult airway.

Keywords: Airway management, difficult intubation, laryngoscopy, simulation training, video laryngoscope.
Materials and Methods
After institutional review board approval, 16 Certified Registered Nurse Anesthetists (CRNAs) from Vanderbilt University Medical Center in Nashville, Tennessee, volunteered to come to the Center for Experiential Learning and Assessment (CELA) to intubate a manikin. The experimental design involved using either the video laryngoscope first (VLF) or the ET tube first (ETTF) technique in normal and simulated difficult airway conditions. The difficult airway was simulated by inflating the manikin’s tongue 50% beyond the normal airway condition. Each participant performed 2 intubations using each technique under both conditions for a total of 4 intubations.

A double randomization of the order of intubation technique and airway difficulty was performed to limit learning bias in the analysis. Volunteers were oriented to the simulation environment (CELA laboratory, video laryngoscope, and manikin) and techniques using a standard script. Participants were blinded to the airway conditions. The intubations were recorded for timing and counting of gaze changes. Following the trials, participants completed a survey providing their opinion and preference of the 2 techniques. Time to intubation was defined as the interval in seconds between picking up the video laryngoscope, or the ET tube, and insertion of the ET tube into the larynx. Gaze change was defined as the shift in gaze between the manikin’s airway and the video laryngoscope screen.

Intubation times and gaze changes were recorded on a spreadsheet (Excel, Microsoft Corp) after review of recorded captured video. Boxplots of intubation time intervals and gaze changes were used to identify and eliminate statistical outliers. An independent 2-group Mann-Whitney (U) test was used to compare differences between the normal and difficult airway conditions. P values <.05 were considered to be significant. Differences were also compared using the participants as their own control by calculating percent changes relative to each participant’s first trial. All analyses were implemented using statistical software (R version 3.6.0).

Results
Boxplots displaying the range of time to intubation and gaze change data are shown in Figures 1 and 2. Significant outliers and episodes of violation of randomization were excluded from analysis. The resultant cohort excluded 1 participant from the VLF normal airway group and 3 from the difficult airway ETTF group for protocol violations. Descriptive statistics from the analysis between the VLF and ETTF techniques are included in the Table. There was no significant difference in time to intubation between the groups (Figure 1). The number of gaze changes decreased using the ETTF technique in both the normal and difficult airway trials (see Table).

Mean percent changes and SEM in time to intubation and gaze changes relative to the participants’ first intubation are graphed in Figure 3. As expected, both the times to intubation and the number of gaze changes significantly decreased with subsequent laryngoscopies.

According to the postexperiment survey, 10 (62.5%) of 16 participants reported that the ETTF technique was as easy as or easier than the VLF technique. In addition, 4 participants (25%) reported that given a choice, they would prefer ETTF as their primary intubation technique.
Discussion

Our study findings did not reveal differences in the time to intubation between the ETTF technique and the VLF technique but did reveal that the number of gaze changes (looking from patient to screen) was significantly fewer. As expected, we also noted a significant learning improvement with each subsequent intubation regardless of randomization. However, we found acceptance of the new technique and will likely include it in a curriculum in the future to introduce the technique as an option.

With the traditional VLF technique, the initial advancement of the ET tube in the oral cavity is performed with a minimal view until the tip of the ET tube is beyond the camera of the video laryngoscope. Because of the blind nature of the advancement, potential exists for injury in the oropharynx, which is well documented in the literature. There are many case reports indicating pharyngeal injury and tonsillar perforation. These injuries are likely because the providers pay undue attention to the view on the video screen at the time of advancement of the ET tube and do not pay adequate attention to the direct visualization of the ET tube’s path into and through the oropharynx. Thus, they inadvertently apply traumatic force with a rigid, styletted ET tube.

Aziz and colleagues studied 2,100 video laryngoscopy-assisted tracheal intubations. They found a 1% incidence of minor soft-tissue injuries and a 0.3% incidence of major complications, such as dental, pharyngeal, tracheal, or laryngeal injuries. In a separate review, Greer et al discovered that palatal injury was much greater in video laryngoscopy–assisted tracheal intubations. They found a 1% incidence of minor soft-tissue injuries and a 0.3% incidence of major complications, such as dental, pharyngeal, tracheal, or laryngeal injuries. In a separate review, Greer et al discovered that palatal injury was much greater in video laryngoscopy–assisted tracheal intubations than with direct laryngoscopy. The authors agree that these injuries may have been a result of the providers not maintaining a direct line of sight while introducing the ET tube into the oral cavity. We believe that the ETTF technique would be associated with fewer complications as the laryngoscopist’s focus would be on directing the ET tube rather than the video screen.

Table. Time to Intubation and Gaze Changes by Technique

<table>
<thead>
<tr>
<th>Airway</th>
<th>VLF technique, mean (SD)</th>
<th>ETTF technique, mean (SD)</th>
<th>P value&lt;sup&gt;a&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal airway, No. 15</td>
<td>15</td>
<td>16</td>
<td>.978</td>
</tr>
<tr>
<td>Time to intubation</td>
<td>15.59 (6.74)</td>
<td>15.69 (8.51)</td>
<td>.978</td>
</tr>
<tr>
<td>Gaze changes</td>
<td>4.25 (1.13)</td>
<td>3.00 (2.73)</td>
<td>.027</td>
</tr>
<tr>
<td>Difficult airway, No. 16</td>
<td>16</td>
<td>13</td>
<td>.843</td>
</tr>
<tr>
<td>Time to intubation</td>
<td>15.88 (6.35)</td>
<td>15.38 (5.12)</td>
<td>.843</td>
</tr>
<tr>
<td>Gaze changes</td>
<td>4.71 (1.86)</td>
<td>2.46 (1.98)</td>
<td>.0009</td>
</tr>
</tbody>
</table>
When the laryngoscopist is intubating a potential or known difficult airway, time becomes a critical limiting factor. Education programs instruct their trainees to navigate these airways using special airway techniques and instruments to facilitate intubation of the trachea. As an adjunct to one such technique, using the video laryngoscope, we hypothesized that the time to successful intubation would be reduced by introducing the ET tube into the patient’s mouth first. Although our study did not show a significant reduction in time, it did demonstrate a lower number of gaze changes in both airway conditions.

We believe that this study was limited by a steep learning curve. The participants were experienced CRNAs who were trained to use the VLF technique and had not been introduced to the ETTF method previously. This was corroborated by the decrease in time and gaze changes that was noted with subsequent intubations (see Figure 3). It is reasonable to assume that increased familiarity with the ETTF technique may further reduce the intubation time by this technique. Additionally, the study may have been limited by the size of the laryngoscope blade, as it seemed large relative to the manikin’s mouth, and there was an unnatural stiffness of the manikin’s airway. We also believe that the ETTF technique leads to a more focused advancement of the ET tube in the oral cavity. This could potentially reduce the likelihood of injury during ET tube advancement that has been observed with the VLF technique.

Anecdotal accounts from our sister hospital have indicated that they have experienced an increase in workflow and a decrease in intubation time using the ETTF technique. Given these results and the substantial learning curve that we noticed, we recommend developing an educational curriculum that could be used to teach this technique and increase the comfort level of providers. Future research could include an in vivo trial in morbidly obese adult patients.

**Conclusion**

Although this study showed no difference in the time for intubation, the reduction in gaze changes was found to be significant with the ETTF technique. This could be useful when instructing providers who are learning airway management with a video laryngoscope. Most study participants stated that they found the ETTF technique interesting and useful. We suspect that further study may show a decrease in time with the ETTF technique compared with the VLF technique after the development of a curriculum. Overall, the ETTF technique was thought to be useful, and further study is warranted.

**REFERENCES**

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**DISCLOSURES**

The authors have no financial relationships with any commercial interest related to the content of this article. The authors did not discuss off-label use within the article.