Body Posture during Simulated Tracheal Intubation: Comparison of the Effects of Video Laryngoscopy and Direct Laryngoscopy

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Tracheal intubation is an important procedure in anesthesia and emergency medicine. The standard intubation technique is direct laryngoscopy using a Macintosh blade; however, video laryngoscopy has become common and research has shown several advantages of video laryngoscopy over direct laryngoscopy. In the present study we investigated whether video laryngoscopy resulted in the intubating person adopting a more ergonomic body posture than direct laryngoscopy. To this end, 25 medical students were video-recorded intubating a manikin using a GlideScope® or a Macintosh blade. Using the GlideScope® resulted in smaller deflections for all analyzed posture angles than using the Macintosh blade. Similarly, the Rapid Entire Body Assessment (Hignett & McAtamney, 2000) indicated that the GlideScope® resulted in a body posture less likely to induce injuries than the Macintosh blade. Overall, video laryngoscopy using a GlideScope® resulted in a more ergonomic posture compared to the Macintosh blade.

INTRODUCTION

Tracheal intubation is an important anesthetic skill and failed airway management is one of the main causes of anesthesia related morbidity and mortality (Caplan, Posner, Ward, & Cheney, 1990). Despite the importance of tracheal intubation and even though technical innovations such as video laryngoscopy have been studied extensively, there has been little research on the best posture for the anesthesiologist when intubating (Matthews, Johnson, & Goodman, 1998; Walker, 2002). Video laryngoscopy has several benefits compared to the Macintosh blade, including reduced forces to the patient’s mouth (Russell, Khan, Elman, Katzenelson, & Cooper, 2012) and a superior glottal view (Cooper, Pacey, Bishop, & McCluskey, 2005). Video laryngoscopy has been shown to reduce the muscular activation of lower arm, upper arm, and shoulder muscles in the person performing the intubation and results in lower subjective physical demand and effort than direct laryngoscopy (Caldiroli et al., 2013). However, to our knowledge, the effect of video laryngoscopy on body posture has not been studied.

The first aim of the present study was to investigate whether video laryngoscopy leads to a more ergonomic body posture than direct laryngoscopy during simulated tracheal intubation. To this end, we measured and compared the posture angles of several body parts when intubating with a video laryngoscope compared to direct laryngoscopy.

Matthews et al. (1998) and Walker (2002) observed that with a standard Macintosh blade, novices adopted a more crouched position when intubating than experts. Although crouching is probably not the best ergonomic posture, the studies did not make an absolute assessment of posture; they only compared the postures of novices and experts. Similarly, Caldiroli et al. (2013) concluded cautiously that muscular activation in video laryngoscopy compared to direct laryngoscopy is the result of differences in posture during the procedure. An alternative explanation is that video laryngoscopy also requires the person intubating to use less manual force than direct laryngoscopy (Russell et al., 2012). The issue of whether direct laryngoscopy causes the intubating person to adopt a posture which may contribute to development of musculoskeletal disorders remains open.

The second aim of the study was to assess the posture of participants when performing intubation with video laryngoscopy or direct laryngoscopy...
using the Rapid Entire Body Assessment (REBA, Hignett & McAtamney, 2000). The REBA enables a more comprehensive assessment of the intubation procedure because it considers posture angles, muscle activity, and coupling between participants and devices. Finally the REBA also provides a REBA action level that indicates the risk of injury associated with the task and need for further task assessment.

**METHOD**

**Participants**

Twenty-five medical students in the 5th year of their MD program participated in the study and gave written consent (12 male, 13 female; mean age = 26 years, range = 23-30 years; mean body height = 176 cm, range = 158-195 cm). All participants had normal or corrected-to-normal eyesight. Seven participants were trained paramedics, two participants were trained nurses, and one participant was a trained dentist. The majority of participants had intubated a human fewer than 5 times (58%) and practiced on a manikin fewer than 10 times (66%).

**Design**

Intubation method (video laryngoscopy vs. direct laryngoscopy) was a within-subjects factor. The dependent variables were various posture angles (neck, trunk, leg, upper arm, lower arm, and wrist) and REBA action level.

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Figure 1. Intubation with the Macintosh blade (A) and GlideScope® (B). Photos on the left show the view from the front camera. Photos on the right show the view from the side camera. Numbers illustrate the various posture angles: (1) legs, (2) trunk, (3) neck, (4) upper arm, (5) lower arm, and (6) wrist.
Materials and Procedure

The study was conducted at the simulation center of the Department of Anesthesia at the University Hospital of Würzburg. Each participant intubated a patient manikin twice, once with a GlideScope® video laryngoscope (Verathon Medical, Bothell, WA, USA), and once with a No. 3 Macintosh blade (Heine Optotechnik, Herrsching, Germany). Half the participants started with the GlideScope® and the other half started with the Macintosh blade. The manikin was a high-fidelity patient-simulator with a standard airway for intubation (METIman® prehospital, CAE Healthcare, Sarasota, FL, USA). The floor-manikin nose distance was set at 115 cm and was not changed during the experiment.

Participants were not given any information about the aim of the study in advance. On each intubation trial participants were instructed to ventilate the patient with an anesthesia bag and mask. The experimenter started the video recording and assisted the participant by passing the devices required. The recording was stopped when the participant inflated the cuff of the tracheal tube or removed the intubation device. Since none of the participants had any experience using the GlideScope®, they watched a three-minute manufacturer’s video which explained the main steps and main differences from direct laryngoscopy when using the GlideScope®. The screen was positioned to the left of the manikin’s head; the floor-screen distance was set at 119 cm and was not changed during the experiment. At the end of the experiment participants completed a short demographic questionnaire.

The video recordings were made using two USB cameras attached to a laptop. The cameras recorded side and frontal views of the participants (see Figure 1).

Analysis

We analyzed the time from blade insertion in the mouth to blade removal or inflating the cuff of the tracheal tube. Each video was analyzed by assessing the posture angles of interest and the REBA measures every 3 seconds. Upper and lower arm measurements always refer to the left side as the intubation device was always held with the left hand.

In addition to posture angles we also scored several other factors required for the REBA including torsion or side flexion of the neck, abducted upper arm or raised shoulders, twisting of the trunk, and bilateral weight bearing on legs. Coupling between hand and device, a load-force score and an activity score were also assigned. We rated coupling (i.e., how well the devices can be held by participants) with both devices “good” coupling. The average force applied with the Macintosh blade is 11 N compared with only 5 N for the GlideScope® (Russell et al., 2012); we therefore assigned load-force scores of 2 and 1, respectively. The activity score considers repetitive dynamic work and prolonged static work. We did not assign an activity score for either device since intubation usually lasts no longer than 60 s.

To test the inter-rater agreement of our scoring, two trained raters coded approximately 12% of the data. Following Bao, Howard, Spielholz, Silverstein, and Polissar (2009), we calculated the interclass correlation coefficient (ICC) for continuous data (i.e., posture angles). The ICCs were acceptable for all posture angles (ICC > .7) apart from the wrist (ICC = .4). Because the wrist is a small joint it is hard to measure the angle and the angle variability is low. In particular low variability tends to produce a small ICC (Bao et al., 2009). For dichotomous variables such as neck torsion we calculated percentage agreement between the raters. Percentage agreement was above 80% for all measures except “deviated or twisted wrist” (60%).

RESULTS

Posture Angles of Body Parts

For all participants we averaged posture measures across frames (time points) and compared conditions (GlideScope® vs. Macintosh blade). To compare the posture angles of the different body parts in the two conditions we calculated six paired t-tests. Alpha was set at .05 for all tests.

Means and standard deviations for the six posture angles are given in Table 1. The t-tests showed that deflections for all six posture angles were significantly smaller when using the GlideScope® than the Macintosh blade (all t values > 2.8, all p values < .01).
REBA Scores

For all participants we calculated a REBA score for all frames analyzed and averaged the REBA score within condition for each participant (GlideScope® vs. Macintosh blade).

A paired \( t \)-test showed that REBA scores were significantly lower when using the GlideScope® (\( M = 2.81, SD = .89 \)) than the Macintosh blade (\( M = 3.73, SD = .82 \)), \( t(24) = 4.943, p < .001 \). This indicates that the GlideScope® resulted in a body posture that is less likely to induce injuries than the Macintosh blade.

Table 1

<table>
<thead>
<tr>
<th>Body Part</th>
<th>Intubation Method</th>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Video laryngoscopy (GlideScope®)</td>
<td>Direct laryngoscopy (Macintosh)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>( M (SD) )</td>
<td>( M (SD) )</td>
<td></td>
</tr>
<tr>
<td>Neck</td>
<td>33 (10)</td>
<td>44 (12)</td>
<td></td>
</tr>
<tr>
<td>Trunk</td>
<td>13 (12)</td>
<td>25 (14)</td>
<td></td>
</tr>
<tr>
<td>Leg</td>
<td>10 (8)</td>
<td>16 (11)</td>
<td></td>
</tr>
<tr>
<td>Upper arm</td>
<td>27 (16)</td>
<td>49 (19)</td>
<td></td>
</tr>
<tr>
<td>Lower arm</td>
<td>85 (15)</td>
<td>97 (13)</td>
<td></td>
</tr>
<tr>
<td>Wrist</td>
<td>8 (8)</td>
<td>14 (13)</td>
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</table>

DISCUSSION

The aim of the present study was to compare the effects on posture angles in the intubating person of video laryngoscopy using a GlideScope® and direct laryngoscopy using a Macintosh blade and to assess both techniques using the REBA (REBA, Hignett & McAtamney, 2000).

The GlideScope® resulted in smaller deflections for all six posture angles compared to the Macintosh blade. When using the Macintosh blade, we observed a crouched position which has been reported previously for novice subjects (Matthews et al., 1998; Walker, 2002). In particular, less flexion of the trunk and the neck when using the GlideScope® resulted in a more erect position (see also Figure 1).

Using the GlideScope® resulted in less flexion of the knees, lower arms, and wrist than the Macintosh blade; however the absolute values for both devices were within the range for a neutral position (cf. Hignett & McAtamney, 2000). For the upper arm both techniques resulted in a larger than neutral flexion; however the Macintosh blade resulted in a larger flexion than the GlideScope®.

Using the GlideScope® resulted in a significantly lower REBA score (\( M = 2.81 \)) than the Macintosh blade (\( M = 3.73 \)). This gave a rounded score of 4 for the Macintosh blade which indicates a medium risk level and that “action and further assessment [of the task] is necessary” (cf. Hignett & McAtamney, 2000). This gave a rounded score of 3 for the GlideScope® which indicates a low risk level and that “action and further assessment [of the task] may be necessary”.

The differences in the REBA score result from differences in the posture angles and forces required to perform intubation using the two devices (see Analysis section). Additional analysis revealed that the Macintosh blade caused participants to twist the wrist and abduct or rotate the upper arm more often than the GlideScope®. Interestingly, the GlideScope® caused participants to twist their neck more often than the Macintosh blade. This is probably due to the position of the GlideScope®’s monitor which was always placed on the left side (see Figure 1).

Overall, the present results are in line with previous research on body posture of novice participants (Matthews et al., 1998; Walker, 2002) and are also consistent with observations that the GlideScope® reduced the activation of several upper body muscles (Caldiroli et al., 2013).
Limitations and Future Research

The study has several limitations. Firstly, we used a fixed operation table height while in clinical practice anesthetists often have the possibility to adjust the table height when intubating a patient. However, none of the participants asked the experimenter to change the setting. The pattern of results was similar for the tallest (> 183 cm, 25th percentile) and smallest participants (< 170 cm, 25th percentile). It is therefore unlikely that table height had a major influence on our results. Secondly, we used a simulated setting and there are differences between human airways and manikin airways (Schebesta et al., 2012). For the present research question, however, it is unlikely that these differences influenced the present results. Thirdly, we only studied the posture of novices and not experienced anesthesiologists. Previous research showed that the postures of novices and experts are different when intubating with a Macintosh blade (Matthews et al., 1998; Walker, 2002). The pronounced differences between the GlideScope® and the Macintosh blade might be smaller or even absent for experienced anesthesiologists. To address this issue, we are currently testing a group of experienced anesthesiologists using the materials and procedures used in the present study.

Implications

The use of the GlideScope® resulted in a more ergonomic posture and a lower REBA score, which indicates a lower risk of injury. From an ergonomic point of view, the GlideScope® should be preferred to the Macintosh blade for laryngoscopy. The advantages offered by the GlideScope® could be increased by changing the position of the monitor so that the monitor is in line with the anesthetist’s eyes in neutral position (i.e., position the monitor above the patient’s chest). In laparoscopic surgery this position resulted in better task performance and less strain of the neck muscles (Matern, Kehl, Giebmeyer, & Faist, 2002).

CONCLUSION

Previous research showed that video laryngoscopy has several advantages over direct laryngoscopy (e.g. Russell, 2012). However, the pros and cons of video laryngoscopy versus direct laryngoscopy are still discussed (Rothfield & Russo, 2012). The present results indicate that using the GlideScope® for laryngoscopy results in a more ergonomic posture than using a Macintosh blade.

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REFERENCES