Original Article

Comparison of Airtraq optical laryngoscope and Storz video laryngoscope in a cadaver model

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BACKGROUND: Airway management in the emergency department is a critical intervention that requires both standard techniques and rescue techniques to ensure a high rate of success. Recently, video laryngoscope (VL) systems have become increasingly common in many large urban EDs, but these systems may exceed the budgets of smaller rural EDs and EMS services and the Airtraq optical laryngoscope (OL) may provide an effective, low-cost alternative. We hypothesized that laryngeal view and time to endotracheal tube placement for OL and VL intubations would not be significantly different.

METHODS: This was a prospective, crossover trial. Setting: University-based emergency medicine residency program procedure laboratory utilizing lightly embalmed cadavers. Subjects: PGY1-3 emergency medicine residents. The study subjects performed timed endotracheal intubations alternately using the OL and VL. The subjects then rated the Cormack-Lehane laryngeal view for each device. Statistical analysis: Mean time to intubation and the mean laryngeal view score were calculated with 95% confidence intervals and statistical significance was determined by Student's *t* test.

RESULTS: Fourteen subjects completed the study. The average laryngeal view achieved with the OL vs. the VL was not significantly different, with Cormack-Lehane grade of 1.14 vs. 1.07, respectively. Time to endotracheal intubation, however, was significantly different ($P<0.001$) with the average time to intubation for the OL 25.49 seconds (95% CI: 17.95-33.03) and the VL 13.41 seconds (10.27-16.55).

CONCLUSION: The Airtraq OL and the Storz VL yielded similar laryngeal views in the lightly embalmed cadaver model. Time to endotracheal tube placement, however, was less for the VL.

KEY WORDS: Airtraq optical laryngoscope; Laryngoscope; Video laryngoscope

World J Emerg Med 2011;2(3):175-178

DOI: 10.5847/wjem.j.1920-8642.2011.03.003

INTRODUCTION

Endotracheal intubation is a critical skill for emergency physicians and the variable anatomy and clinical situations encountered in clinical practice require both standard and rescue techniques to ensure optimal care for all patients requiring airway management.

The standard technique for visualization of the glottis, direct laryngoscopy is difficult in approximately 2%-5.8% of patients according to most reports, but may approach 30% for patients requiring emergency airway management.^[1,2] Prediction of difficult direct laryngoscopy is problematic and all personnel

responsible for emergency department (ED) patients must prepare for these relatively rare events prior to every intubation attempt. Difficult laryngoscopy results from both anatomic variants and clinical factors that limit the alignment of the oral, pharyngeal, and tracheal axes and requires techniques and devices designed to overcome these limitations. Recently, the devices which eliminate the need to fully align the three axes, such as the video Macintosh laryngoscope (VL) system (Karl Storz, video Macintosh laryngoscope system) have become increasingly common in many large urban EDs, but these systems may exceed the budgets of smaller rural EDs and emergency medical service (EMS) systems. An optical laryngoscope (OL), the Airtraq (King Systems, Noblesville, Indiana), is a new intubation device that also allows for visualization of the glottis without alignment of the oral, pharyngeal, and tracheal axes, and may provide an effective, lower-cost alternative to the VL.

We hypothesized that best laryngeal view and time to endotracheal tube placement for OL and VL intubations would not be significantly different.

METHODS

The study protocol was approved by the local institutional review board and all subjects provided informed consent. We conducted a prospective, cross-over trial in a university-based advanced anatomy procedure laboratory utilizing a lightly embalmed cadaver. A single cadaver was lightly-embalmed using a modification of a previously described technique that preserves tissue texture and elasticity. The preparation of lightly-embalmed cadavers for anatomical study was first described by Anderson.^[3] The donor used in our study was similarly prepared using a glutaraldehyde rather than formaldehyde-based chemical. The carotid artery was first injected with approximately 8 liters of Champion Millenium Co-Inject Beta Factor diluted at 1:16 with tap water. In contrast to the method described by Anderson, the internal jugular vein of the cadaver was opened prior to injection of Beta Factor to allow free drainage. Next, the carotid artery was injected with approximately eight liters of Champion Millenium Arterial 24 Alpha Factor diluted, at 1:10 to 1:16 with tap water. Both fluids were injected at 500 mm Hg at a flow rate of 400-500 ml per minute. The cadaver was then stored supine in a plastic bag at 4° Celsius. The subjects included postgraduate year (PGY)1-3 emergency medicine (EM) residents ($n=14$) with no prior experience with OL or VL laryngoscopy. All subjects provided informed consent to participate in the study. Following a five minute instructional session for each

device, the study subjects performed timed sequential endotracheal intubations using the OL and VL, with each subject alternating the initial device. The subjects then rated the Cormack-Lehane (CL) laryngeal view for each device and indicated their overall preference of device. The mean time to intubation and the mean laryngeal view score were calculated with 95% confidence intervals and statistical significance was determined by Student's *t* test. Degradation of the model over the course of the study or evidence of linear trend was assessed using linear regression.

RESULTS

Fourteen subjects were enrolled and completed the study: five PGY1, six PGY2, and three PGY3. The average laryngeal view achieved with OL vs. VL was not significantly different, with the mean CL grade of 1.14 and 1.07, respectively ($P=0.5585$). Time to intubation, however, was significantly different ($P<0.001$), with the average time to intubation for the OL being 25.49 seconds (95% CI: 17.95-33.03) and for the VL 13.41 (10.27-16.55). No significant model degradation was noted over the course of the study, with a *P* value 0.2526 for laryngeal view for the OL and 0.3407 for the VL and 0.5307 and 0.9682 for time to intubation, respectively.

Twelve out of 14 subjects indicated a preference for the VL over OL. Ease of manipulation of the endotracheal tube was given as the reason for all 12 favoring the VL. Of the two remaining subjects, both reported some difficulty in advancing the endotracheal tube beyond the vocal cords with the VL.

DISCUSSION

Observing the passage of the endotracheal tube between the vocal cords is the gold standard for safe placement of an endotracheal tube, but anatomic and clinical constraints may prevent the necessary laryngeal view by direct laryngoscopy. For direct laryngoscopy, alignment of the oral, pharyngeal, and laryngeal axes is necessary to view the glottis, but line-of-sight visualization may be impossible for some patients secondary to anatomic factors.^[4] Devices allowing the clinician to overcome these obstacles are of critical importance in airway emergencies. Studies reported improved laryngeal view with airway devices allowing for indirect visualization of the glottis in difficult airway models.^[5] Both devices in the current study allowed the intubator to view the glottis indirectly, overcoming anatomic constraints. Recent studies have

reported improved glottic views for Storz VL over direct laryngoscopy in both adult and pediatric patients, none to date compare Storz VL to Airtraq OL.^[6,7]

In addition to anatomic variation, certain clinical situations may further complicate direct laryngoscopy, making devices such as Airtraq OL and Storz VL as critical equipments in the ED. Clinical factors affecting direct laryngoscopy include ED patients with limited cervical spine mobility, including trauma patients with potential cervical spine injuries. Investigators observed less cervical spine motion by intubation with Airtraq OL than with direct laryngoscopy using a Macintosh laryngoscope.^[8,9] Airtraq OL was compared with direct laryngoscopy in both manikins and anesthetized patients. A manikin study revealed that inexperienced intubators favored optical laryngoscope for both normal and difficult airways, including limited cervical spine mobility.^[10] A study of anesthetized patients with manual inline axial stabilization to limit cervical spine mobility showed improved glottic view and reduced duration of intubation attempts when comparing Airtraq OL and direct laryngoscopy with a Macintosh blade.^[11] In fact, clinical situations with limited cervical spine mobility, while problematic for direct laryngoscopy, do not adversely influence Airtraq OL as optimal patient position for intubation using this device was found to be inline head and neck position.^[12] No studies compared cervical spine motion using Storz VL instead of direct laryngoscopy.

We first compared laryngeal view between Airtraq OL and Storz VL, and found no significant difference in laryngeal view between the two devices in a lightly embalmed cadaver model, with all subjects reporting either a Cormack-Lehane I or II view on all intubation attempts. While we found no difference in laryngeal view, the finding that all subjects reported either a CL I or II view for both devices is clinically significant as these laryngeal views correlate with a successful intubation.^[13,14] All intubations performed in our participants were successful no matter whether Airtraq OL or Storz VL was used.

In our study, the time to intubation was less for Storz VL than Airtraq OL, with a slight difference of greater than 12 seconds that was statistically significant. Time required to place an endotracheal tube is important, but the clinical significance of a difference of approximately 12 seconds is uncertain. Other studies^[5,15] reported decreased time to intubation for OL over various rescue devices including the Glidescope VL and the laryngeal mask airway (LMA) CTrach, another video-assisted device, but none of them addressed the time to intubation for OL versus VL.

The subjects in our study indicated an overall

preference for Storz VL over Airtraq OL. Twelve out of 14 subjects indicated that VL allowed for a smoother passage of the endotracheal tube, a factor that may have influenced total time to intubation as well, although we did not measure the time increment from visualization of the glottis to successful passage of the tube through the vocal cords. Studies found a decreased time to intubation for Airtraq OL as compared with a video scope, the Glidescope credited the tube track for facilitating more rapid tube placement, whereas we suggest that the tube track hindered the intubator from freely manipulating the tube to facilitate rapid placement.

Acquisition of effective and timely skills is important for any device utilized in critical care situations, but the very low numbers of difficult airways encountered in emergency practice make skills maintenance for such devices an important consideration. Studies comparing the learning curves for various devices in a difficult airway scenario demonstrated a more favorable learning curve for Airtraq OL.^[16] Studies have demonstrated that Airtraq OL is easily mastered by novice laryngoscopists.^[17] Our findings suggest that a brief instructional session results in acquisition of adequate skills for both devices. For Airtraq OL, the manufacturer recommends two to four intubations using the device prior to its use in a difficult intubation scenario.

The financial resources of each ED may affect the choice of rescue device. Storz VL is a multiple-use device with an initial cost of \$45-55 000 and recurrent maintenance and cleaning costs of approximately \$35-\$55 for each use at our facility. The cost for the single use, disposable Airtraq OL is approximately \$50.00-\$85.00 per device, depending on vendor. Low resource, low volume EDs with limited budgets as well as low volume EMS/rural EDs may lack the financial resources to purchase the VL system, but still require an effective, low cost alternative.

Limitations

A possible limitation of the model is the effects of serial intubations on the tissue texture and elasticity of the lightly embalmed cadaver; however, statistical analysis did not reveal any decay. As the cadaver is removed from refrigerated storage and begins to approximate room temperature, the tissues become more compliant, potentially impacting ease of intubation. To remedy this potential limitation, the cadaver in this study was removed from refrigeration two hours prior to data collection and allowed to warm to room temperature. In addition, each subject alternated the use of each device, so that the potential effects of any change in the tissue

characteristics of the cadaver would be evenly distributed between the two groups.

In our study we did not measure the amount of time necessary for preparation of each device and the time increments for each specific task involved in laryngoscopy: equipment preparation, insertion of device, tube passage between the vocal cords. To more fully assess the clinical aspects of each device, the time to scope passage at the lip to optimal glottis view is needed, as well as the time from achieving optimal view to passage of the endotracheal tube. These specific time increments, if significantly different, may suggest advantages of one device over the other in terms of preparation time and ease of tube passage. From clinical experience, the preparation time required for Storz VL, including the time required to connect to a power source, power up, focus, and white balance, would likely result in an increase in the overall time for intubation for this device over Airtraq OL. Unfortunately, the magnitude of the additional time required for device preparation remains unknown.

Further limitations include the small number of subjects included in the study and the variable clinical experience of our subjects. We recruited all EM residents currently training in our program, but participation was limited to 14 due to clinical responsibilities. In addition, the variable airway management experience typical of a group of PGY1-3 residents may affect our results, but no participating resident reported clinical experience with either device before the initiation of the study.

In conclusion, Airtraq OL and the Storz Video Macintosh Laryngoscope System yielded similar laryngeal views in the lightly embalmed cadaver model. Time to placement of an endotracheal tube was less for Storz VL, but did not account for device preparation time.

Funding: None.

Ethical approval: The study was approved by the IRB of the University of Nebraska College of Medicine.

Conflicts of interest: The authors have no commercial associations or sources of support that might pose a conflict of interest.

Contributors: Wadman MC proposed and wrote the first draft. All authors have made substantive contributions to the study, and all authors endorse the data and conclusions.

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Received April 16, 2011

Accepted after revision August 19, 2011