Airway management at Level 1 trauma center in the era of video laryngoscopy

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ABSTRACT

Background: Rapid sequence induction and tracheal intubation through direct laryngoscopy (DL) has been the most common approach to secure the airway in trauma patients. The introduction of video laryngoscopy (VL) has changed airway management in many clinical settings. In this retrospective study, we assessed if immediate availability of VL in the trauma suite has changed the approach and outcomes of airway management during acute resuscitation at a dedicated trauma center.

Materials and Methods: We retrospectively collected data from emergency intubation in the 6 resuscitation bays at a high-volume, academic, Level 1 trauma center over a 42-month period following the introduction of immediately available VL in the resuscitation bay. We divided the data into 13-week bins to assess the trend in the use of VL over time. Our measured outcomes were the incidence of failed intubations requiring a surgical airway and the frequency of VL use for airway management.

Results: Among 1328 airway management events in the resuscitation bays when intubation was attempted, the failure rate resulting in the placement of a surgical airway was 0.38% (95% confidence interval [CI], 0.12%–0.88%). This was consistent with the surgical airway rate before the introduction of VL into trauma practice (0.3%). VL use (primary or as a rescue technique) throughout the study period was 4.14% (95% CI, 2.76%–5.74%), with no temporal trend.

Conclusion: The immediate availability of VL in the resuscitation bay has not changed the prevalence of its use during emergency airway management at our trauma center. DL remains a preferred primary modality for airway management by the trauma anesthesiologists working at this facility, with an acceptably low incidence of both primary failure and the need to establish a surgical airway.

Key Words: Airway management, laryngoscopy, traumatic injury

INTRODUCTION

Rapid sequence induction and orotracheal intubation is the preferred method to secure the airway in trauma patients, as recommended by the ATLS guidelines and the Eastern Association for the Surgery of Trauma.[1] The prevalence of failed intubation on admission to the hospital has previously been estimated in the range of 0.3%–2.7%, varying by center and the specialty of the responsible physicians.[1–3] Previously, a trauma airway management algorithm mainly relying on direct laryngoscopy (DL) with the only adjuvants being a bougie or supraglottic airway (SGA) at a Level 1...
trauma center, staffed by a dedicated team of trauma anesthesiologists, was demonstrated to have a success rate of 99.7%.[3] However, at the time of publication, video laryngoscopy (VL) had just been introduced and the authors acknowledged that these instruments could change future practice.[3] In less specialized settings, failed laryngoscopy requiring airway rescue has a higher prevalence of 2.7%.[2] A recent pragmatic study of trauma airway management demonstrated that 55% of emergency medicine physicians opted for VL as their initial approach.[4] While VL has been shown to improve the laryngoscopy view, this does not necessarily translate into successful intubation. Although both DL and VL have the same success rate in first-pass intubation,[5] the time required with VL was reported to be longer.[6]

At our Level 1 trauma center, DL supervised by trauma anesthesiologists is the established initial method of airway management. Multiple video laryngoscopes, GlideScope (Verathon Medical, Bothell, WA, USA), and C-MAC (Karl Storz, Tuttingen, Germany) with hyperangulated blades have been immediately available adjacent to the resuscitation bays since 2014. In this retrospective study, we examined if the immediate availability of VL changed either the approach to airway management or the prevalence of failed intubations requiring a surgical airway. Our first hypothesis was that the use of VL in the trauma bays would be <10%, which has been described as the rate of poor view of the vocal cords with DL.[7] Our second hypothesis was that there would be no trend for increased use of VL over time.

**MATERIALS AND METHODS**

The present study was approved by the local Institutional Review Board (IRB #20170433) with a waiver of written informed consent. The study was designed entirely by the authors, and no funding was obtained. This retrospective observational study was written in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology Guideline.[8]

The trauma registry was screened, and the charts were reviewed for patients who had endotracheal intubation, tracheostomy, or cricothyroidotomy, for the period from January 1, 2014, to June 30, 2017.

The anesthesia presence in our trauma bays is comprised anesthesiology residents on a dedicated trauma rotation, supervised by faculty anesthesiologists. The team responds to every trauma activation and is responsible for all nonsurgical emergency airway management. The approach to trauma airway management is guided by a previously reported algorithm that can be modified at the discretion of the attending anesthesiologist.[9] The first laryngoscopy attempt is usually a single DL performed by a junior anesthesiology resident, progressing to a senior resident or attending, and finally incorporating adjuncts to laryngoscopy by the third attempt [Figure 1].

All patients who underwent intubation in the trauma resuscitation bay were included in the study. Patients who arrived with an endotracheal tube in place were excluded as were patients who were transferred from the resuscitation bay with a natural airway to one of the trauma odds ratios. Airway management data, including the number of laryngoscopy attempts, the laryngoscopy technique(s) employed, and the airway equipment used were collected. The study endpoints were the prevalence of failed intubations requiring the placement of a surgical

![Figure 1: Airway management algorithm used in the resuscitation bays at our Level 1 trauma center. All emergency airway intubations in the resuscitation bays are conducted by anesthesia residents, supervised by a trauma anesthesiologist. Alterations to the protocol are at the discretion of the anesthesiologist. Surgical airways, if needed, were placed by a trauma surgeon](image-url)
airway or frequency of intubations performed with VL as a primary or rescue technique.

**Statistical analysis**

Percentages are reported as the mean and the 95% binomial confidence interval (CI). To examine temporal trends in VL use, data were batched in 13-week bins for the analysis to remove the potential effects of autocorrelation (e.g., due to the same team taking care of sequential patients). The rate of successful intubation on the 1st or 2nd attempt was determined using the method of batch means. As the prevalence of use of VL and placement of surgical airways were small, the Freeman-Tukey double arcsin transformation was applied to each of the 14 bins. Means among the 14 bins were compared to 10% using the one-group two-sided Student t-test. The presence of a trend in the use of VL was assessed using the Wald-Wolfowitz runs test (Systat v13.1, Systat Software Inc., San Jose, CA, USA).

To detect a difference between the estimated prevalence of use of VL of 5% and a rate of 10% at α = 0.05 and with 80% power, 13 sample periods would be required.

**RESULTS**

We identified 1328 airway management encounters involving the intubation of the trauma patients during the 42-month study period after reviewing 1836 patient charts. Five hundred and eight patients were excluded because they arrived intubated or intubation was performed in the operating room [Figure 2]. Over the entire period, eight surgical airways were placed, a rate of 0.60% (n = 14 bins; 95% CI, 0.26%–1.18%). There were five failed intubations requiring the placement of a surgical airway, a rate of 0.38% (n = 14 bins; 95% CI, 0.12%–0.88%). Of the five-failed intubations, four patients had facial and neck trauma, whereas the fifth patient arrived receiving cardiopulmonary resuscitation with copious blood in the mouth. Multiple laryngoscopies were attempted in all five patients, including VL in two of the five patients and flexible intubating bronchoscopy in one patient. An SGA was placed in two of the five patients [Table 1]. Three patients did not have laryngoscopy attempted due to extensive upper airway trauma.

The prevalence of use of VL in the resuscitation bay during intubation over the 14 complete quarters in the dataset was 4.14% (95% CI, 2.76%–5.74%; P < 0.001 compared to 10%). Among the patients intubated with VL, this was the primary intubation technique in 60.7% (95% CI, 47.3%–72.9%) and a rescue tool after a failed DL attempt in 39% (95% CI, 27.1%–52.7%). There was no trend for increased use of VL over the study period (P = 0.69).

Among patients who had a DL as the first method of attempted intubation, the first-pass success rate was 83.2% (95% CI, 80.1%–86.3%). Intubation was successful within two attempts in 97.3% (95% CI, 96.5%–98.1%) of patients. Among all intubations, VL was used as a rescue method after failed DL in only 1.8% of patients (95% CI, 1.2%–2.7%). Other adjuvant airway devices used included a bougie in 0.53% (95% CI, 0.21%–1.08%), SGA in 0.30% (95% CI, 0.21%–1.08%), and flexible intubating bronchoscope in 0.3% (95% CI, 0.21%–1.08%).

**DISCUSSION**

In our practice, at a high-volume, Level 1 trauma center that is staffed at all times with anesthesiologists who are responsible for emergency airway management, the immediate availability of VL did not translate into increased use of this modality. Rather, the prevalence of VL use was stable, and the rate of surgical airways has remained acceptably low. Our approach is consistent with previous studies showing no difference in the intubation success rate comparing DL to VL in the hands of experienced laryngoscopists. Our continued success with DL during emergency intubation in the trauma resuscitation setting likely explains the absence of a shift to VL over the study interval.

![Figure 2: Inclusion and exclusion of patients identified in trauma registry as having had an airway management procedure in their hospitalization](Image 57x76 to 296x252)

**Table 1: Surgical airways in trauma bay**

| Mechanism of injury | Number of laryngoscopy attempts | Number of face or neck trauma used | Video laryngoscopy used | Adjuvants | Oropharyngeal Soiling |
|---------------------|---------------------------------|-----------------------------------|------------------------|-----------|----------------------|
| Blunt, MVC          | 3                               | Facial                            | No                     | None      | Blood                |
| Blunt, MVC          | 3                               | Facial                            | No                     | None      | Blood                |
| Blunt, PHBC         | 2                               | Neck                              | No                     | SGA       | None                 |
| GSW, Face           | 3                               | Facial                            | Yes                    | FOB       | None                 |
| Blunt, PHBC         | 0                               | No                                | No                     | None      | None                 |
| Blunt, MVC          | 0                               | Both                              | No                     | None      | None                 |
| GSW, Face           | 0                               | Both                              | No                     | None      | Blood/Teeth          |
| GSW, Face           | 4                               | Facial                            | Yes                    | Bougie,   | Blood/SGA            |

FOB: Flexible bronchoscope; GSW: Gunshot wound; MVC: Motor vehicle collision; PHBC: Pedestrian hit by car; SGA: Supraglottic airway
Our experience contrasts with the reports from other centers where initial airway management is performed by emergency physicians rather than anesthesiologists. This might be explainable by greater experience with laryngoscopy among anesthesiologists. Several studies have demonstrated improved glottic visualization and intubation success rate by nonanesthesiologists both in the emergency room and intensive care unit (ICU) setting comparing VL to conventional laryngoscopy. For less experienced laryngoscopists, VL could provide benefits by improving the glottic view during suboptimal intubating conditions. In a randomized clinical trial comparing DL to VL in ICU patients, failed first-attempt intubation by pulmonary critical care trainees with DL resulted in >80% success intubating on the next attempt with VL. However, the first-pass intubation success rate with DL in this study of pulmonary critical care trainees was only 40%, an extremely low success rate by anesthesiology standards. Thus, such results cannot be extrapolated to a setting where laryngoscopists with greater experience are involved. In our study, we had an 83% success rate in first attempt DL, typically performed by a junior anesthesiology resident under the direction of an attending anesthesiologist. The initial success rate almost certainly would have been higher had a more experienced anesthesia resident or attending made the first attempt.

Previous work has shown no difference in the first-pass success rates comparing VL to DL by anesthesiology and emergency medicine residents, but there was a statistically significant increase in the time needed (12–16 s longer; P < 0.01) for intubation with the use of VL, both in the emergency setting and during elective airway management. The increased time needed for intubation with VL may not be clinically important during elective intubations but could be relevant in trauma patients who may already be hypoxic or where there was inadequate time to ensure adequate preoxygenation. Subset analysis of trauma patients with severe head injury demonstrated an increase in significant hypoxemia (50% vs. 24%, P = 0.004) and mortality (30% vs. 14%, P = 0.047) with the use of VL compared to DL. In another multicenter randomized ICU study comparing VL to DL, with routine use of neuromuscular blockade and a broad range of providers, first-pass success rate (67.7% vs. 70.3%, P = 0.60) and time of intubation (3 min, P = 0.95) were similar between groups, with a significantly higher incidence of severe life-threatening complications occurring in the VL group (9.5% vs. 2.8%, P = 0.01). Profound hypoxemia was most notable among these life-threatening complications. These occurrences of hypoxemia during VL may be explained by the difficulty with maneuvering the tracheal tube through the vocal cords and into the airway despite the presence of an adequate glottic view. This can lead to a more prolonged attempt since the failure of tube placement during DL tends to be due to an immediately apparent poor glottic view and earlier transitions to an alternative strategy. Studies evaluating the speed and ease of intubation with VL have shown faster intubation with greater ease when a deliberately restricted view of the glottis was obtained (the blade was positioned more proximally than is typically the case to expose <50% of the glottic opening; i.e., a Cormack-Lehane Grade 2 view) as opposed to a full view. The acute angle of the VL blade may lead to difficulty with tube positioning. A recent meta-analysis of randomized controlled trials demonstrated that intubation success in emergency and critically ill patients was not improved by VL compared to DL and could be worse when experienced laryngoscopists are involved. Soiling of the oropharynx with blood or gastric contents are common in the trauma setting and could cause problems from obscuring the lens of the VL.

Our study has several limitations. The investigation was conducted at a single center where a small group of experienced trauma anesthesiologists were present for all airway interventions. The generalizability of this study is limited due to the single-center design and the specialized group of physicians performing airway management. In many centers, emergency medicine physicians are involved in the initial airway evaluation and management, with anesthesiology playing a backup role in only selected trauma activations. Our study was performed retrospectively, creating the possibility that some airway attempts were either undocumented or misclassified. However, this is unlikely to change our results given our sample size and the low frequency of utilization of either VL or placement of a surgical airway. As the final limitation, the first attempt at intubation was performed by residents with differing levels of experience in laryngoscopy.

CONCLUSION

The immediate availability of VL in the trauma resuscitation bays at a large, academic, Level 1 trauma center at which emergency airway management directed by anesthesiologists did not significantly alter the prevalence for the initial mode of laryngoscopy from DL to VL. Surgical airway rates remained extremely low. DL after rapid sequence induction at our Level 1 trauma center remains the preferred method of airway management by experienced anesthesiologists when intubation is required.

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Conflicts of interest
There are no conflicts of interest.
Ethical conduct of research
This study was approved by the Institutional Review Board/Ethics Committee. The authors followed applicable EQUATOR Network (http://www.equator-network.org/) guidelines during the conduct of this research project.

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